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Of nature trusts the Mind that builds for aye"—WORDSWORTH

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SOCIOLOGICAL ASPECTS OF PRODUCTION COMMITTEES

THE critical importance of establishing effective relations between management and workers in relation to production has been noted in more than one report of the Select Committee on National Expenditure, and one of the main objects of the Joint Production Advisory Committees now being set up is to assist in such integration and to eliminate the misunderstandings which arise when, for example, workers are unaware of the real causes of idle time and other interruptions in production. This factor, it should be noted, is increasingly liable to operate as the mobilization of our industrial man-power and woman-power approaches its limits. There is less and less margin to prevent an interruption at one point causing delays and even more serious interruptions elsewhere.

The value of such attempts to give the workers a true picture of the situation has been well illustrated in a recent visit of a deputation from a local trades and labour council to an ordnance factory, which was reported in the House of Commons. The deputation had full liberty to talk to any employee or shop steward, and the conversations described in the report show how unfounded most of the complaints of idle hours, idle machines and lack of sympathy between management and workers proved to be, and how high an opinion the deputation formed of the personnel and welfare management of the factory compared with private industry. Sir Frederick West, chairman of the North-Western Regional Board of the Ministry of Production, commenting on unfair and inaccurate statements in the report of the Amalgamated Engineering Union on war production with reference to management, confirmed that the Regional Board's own experience in dealing with allegations and rumours criticizing management had indicated that they were mostly unfounded or grossly exaggerated. More substantial grounds of criticism, it is true, are revealed in the investigations of complaints regarding two royal ordnance factories described in the Ninth Report of the Select Committee on National Expenditure, but even here the report shows that the troubles were very largely those which are invariably experienced in starting a factory with an excessive proportion of untrained workers. The superintendents of both factories were fully alive to the problems which confronted them and were doing their utmost to overcome difficulties. Many of the allegations were considerably exaggerated and on most of the matters action had already been taken, though the Select Committee's recommendations, particularly in regard to supervision, the co-ordination of inspection and production, the keeping of records, the handling of transport difficulties and the abolition of Sunday work have a much wider pertinence than in the two factories investigated.

The value of the Joint Production Committees as a weapon of democracy, enabling workers and employers to collaborate in one common and urgent drive, receives powerful support in a recent broadsheet of Political and Economic Planning (P E P). The workers, accepting the responsibility of full participation in the war effort, are beginning to think in terms of 'we' instead of 'they', and are proving that as efficient collaborators they can be far more than mere mechanical factors of production. By enlisting the intelligence and experience of the men who work with their hands, these Committees enable us to make fuller use of the man-power of Great Britain, and they should in this way do something to meet that shortage of efficient and experienced managers which in places so seriously handicaps our war effort.

If at the same time the fresh brains give an impetus to co-operation and improve the efficiency of production, the Committees will prove themselves unmistakably weapons of war, with the advantage that they could equally prove weapons for winning the peace. The importance of the Production Committees should not in fact be judged only by the extent to which they improve the organization of production. They should be judged also by the changes they effect in the attitude of workers and managements to each other in production relations. It is probable that the Committees will strengthen rather than undermine the trade union movement; they may also lead to a more open mind and a wider outlook on industrial and social affairs on the part of organized labour. This should facilitate the handling of some of the problems of post-war reconstruction as much as it will immediately further the contribution of the workers of Britain in the world-wide struggle for democracy.

The Joint Production Committees are an essentially new development, the strength and significance of which cannot yet be adequately judged, and there are still many obstacles in the way of their success. Some managers oppose them as a superfluous addition to an already widely ramified administrative system. Some trade unionists, on the other hand, are resisting the new Committees on the ground that they are instruments of that industrial collaboration which they have always fought.

Political and Economic Planning has therefore rendered a national service in bringing out so promptly a broadsheet which outlines the facts and sets this new development in its true perspective against the Whitley reports and the experience of works committees and councils, as well as sketching the growth of Production Committees up to their official recognition in February 1942. Success or failure of individual committees will undoubtedly depend largely on the personality of the chairman. He must be capable of bringing out the best in the members, encouraging them to speak frankly, and inspiring open-mindedness, independence and energy. Trade unionists, however, have also a great responsibility for the success of the Committees, and they should not fail to realize the important part which the Committees may play in promoting efficiency. Moreover, this development is so clearly in line with movements in the industrial life of our allies, the United States of America and the U.S.S.R., that it may be of great significance in furthering co-operation with these great countries after the War in the task of restoring order and hope and a new standard of living to the shattered world.

While the main purpose of these developments is to promote the efficiency of our war effort, they have a long-term objective which should not be overlooked. We cannot hope to build a new and more equable social order after the War without mutual confidence and trust between management and workers. The standard of industrial relations which best serves the nation's immediate purpose in war is exactly that which best promotes social justice and order in times of peace. There could be no better illustration of this than the coal industry, in which the attitude of both workers and employers has often been a serious threat to the war effort. What is no less apparent to every impartial observer is the high price which the nation has had to pay for such intransigence and sectionalism in the past. The repercussions on our social economy as a whole in the past twenty or thirty years make the coal industry the very first place where the Government should be required to prove that private and sectional interests shall no longer be allowed to obstruct the national purpose.

The highly suggestive report on "Fatigue of Workers: its Relation to Industrial Production" which was published last year in the United States by the Committee on Work in Industry of the National Research Council, is of particular interest in this connexion. It is no disparagement of the scientific or technical work on the elimination of fatigue, the improvement of conditions of work and prevention of accidents, to emphasize, as this report does, that such physical conditions may be of secondary importance compared with the psychological or social conditions. Neglect of the latter has undoubtedly been a main factor in the persistence of such unhappy conditions in the coal industry.

The National Research Council's report is in the tradition of that line of fundamental research on which Dr. Elton Mayo lays such stress in his stimulating volume "Human Problems of an Industrial Civilisation", and it includes some account of those researches at the Western Electric Co. at Hawthorne which are described in that book as well as in T. N. Whitehead's "The Industrial Worker" and elsewhere. This section of the book, together with the chapter which summarizes and discusses Mr. C. I. Barnard's book "The Functions of the Executive", give it a significance far beyond that indicated by its title, and it merits careful study by all those concerned with the improvement of industrial relations, whether from the point of view of war production or of reconstruction after the War.

One of the most striking features of the book is the illustration it gives of the lack of knowledge of each others' minds and purposes on the part of management and worker even in such a progressive firm as the Western Electric Co. The investigators formed the opinion that management really knew very little about what constituted good supervision, or what the employees thought about their conditions of work. This lack of communications is responsible for the failure to secure the desired results even when good working conditions have been established. An executive order without the participation of the workers may be, and often is, ineffective.

The report points out that, pre-occupied with the continual study of its methods so as to make them more efficient, and making inaccurate assumptions about the motives and behaviour of employees, management gives a series of orders which are transmitted through a hierarchy of supervisors to those doing the physical work. At that level the action does violence to the workers' sentiments and is felt to be a threat to their informal organization, and restrictive or protective action by the workers results. Because technical organization is geared to rapid change, while social organization cannot change rapidly, the latter tends to protect itself by retarding change.

The question of communication itself, however, is both upwards and downwards. Where it is fully established and the worker understands the changes that are proposed and the purposes to be served, co-operation becomes effective and the difficulties tend to disappear. Where for any reason communication both upwards and downwards is good, satisfaction is high and authority is strong.

It is therefore of the utmost importance for management to ensure that the generalizations on which it must in practice rely are accurate and not weighted too heavily by the logic of efficiency and economics. Equally, it must recognize the way in which authority arises out of the collaboration of the individuals affected. The first responsibility for the establishment of communications is that of management downwards, for failure in that direction is at once the cause of failure in the upward direction from the worker.

The second outstanding point which emerges from this report and the researches at the Western Electric Co. is the demonstration of the significance of informal organization. Such organization always exists in conjunction with formal organization, but the importance of its two functions are only now becoming recognized: to transmit information and understandings which, for one reason or another, cannot be transmitted by the formal communication system, and to allow means for individuals to escape from certain effects of formal organizations which tend to disintegrate the personality. The place of the social group in industry presents indeed a most promising field of investigation, for the autonomous groups of M. Dubreuil's scheme are by no means the only means of eliminating the sense of frustration or repression of individuality which large-scale mechanized industry, however well directed, is apt to engender.

No one can put down this highly suggestive report without realizing how much we have yet to learn from the formal study of human organization, both in furthering the war effort and in building the peace. What Mr. Barnard has to say about the aspects of executive work which are aimed at securing co-operation are also important. Purpose is indeed the unifying principle of organization, and experience of nearly three years of war, endorses all that the report observes on this point. What is required to date is in fact to interpret the nation's purpose and its needs so that they are understood by every citizen upon whom it calls for service. Only such understanding and acceptance can call forth the immense moral as well as physical effort required to carry the United Nations to victory. In Great Britain no less than in the United States, the committee of the National Research Council has made a noteworthy contribution to creative thinking and to social and industrial efficiency which has both short- and long-range significance.

CRATER LAKE

Crater Lake: The Story of its Origin

By H. Williams. Pp. xxii+100+10 plates. (Berkeley, Calif.: University of California Press; London: Cambridge University Press, 1941.) 10*s*. 6*d*. net.

WE have good reason to be grateful to both Canada and the United States for their contributions to peace as well as to war. Among their most precious gifts are the national parks of the glorious West, which they have consecrated for all future time to the service of humanity. The larger examples, such as Jasper, Yellowstone and the Grand Canyon, harbour men and bears on terms reminiscent of the Garden of Eden. The park of Crater Lake, Oregon, covering roughly 300 square miles, of which a tenth is submerged, is too small to share in this particular distinction; but the blue of its lake and the gay tints of the surrounding cliffs lead some of its devotees to acclaim it as the most beautiful place in the world. Perhaps these enthusiasts have never visited that other park which contains Lake Louise in Alberta; perhaps they say 'most beautiful' when they really mean 'most fascinating'. Be this as it may, all who have had the privilege of visiting Crater Lake admit its rare loveliness, combined with an intellectual stimulus of quite exceptional quality. It is scarcely possible to stand on the rim of the crater and avoid asking the question: How did it happen?

Fortunately, the two great countries concerned, each within its own boundaries, in the conduct of the national parks of the West clearly recognize the educational possibilities of these institutions. In the United States, J. C. Merriam, chairman of the appropriate committee of the National Academy of Sciences, has helped and encouraged Howel Williams to produce the booklet under notice, which goes far to satisfy the most inquiring visitor. The booklet is excellent in plan, language and illustration—including two coloured plates by Paul Rockwood—excellent, in fact, in all respects but price.

The booklet is in two parts: the first aims at describing the changing scenes of the past as though recorded by a succession of eye-witnesses; the second at presenting some of the evidence in the form of a discussion between a Park Guide and a group of questioning tourists.

The first part is quite unusual. It adopts in language the technique of the illustrator, who occasions no surprise if he does portray in picture, model or diorama the details of an imagined scene of long ago, where only broad outline has really been established. Thus Howel Williams tells of the growth of Mount Mazama, and of the destruction of its summit to yield a caldera site for Crater Lake, with the same confidence in print as Paul Rockwood manifests in paint. Here is what we read of the entry, be it remembered in prehistoric times, of Mount Mazama upon the phase of explosive activity that served as prelude to the stage of caldera formation:

"The opening day was clear and the morning light shone brilliantly on the ice around the summit. Suddenly there was an ominous rumbling underground, and a moment later a plume of steam rose from the crater. The slumbering volcano had awakened."

One is reminded of the younger Pliny's account of the resurrection of volcanic activity at Vesuvius, A.D. 79, an account which many historical critics in after-centuries considered fiction until at last it was confirmed by excavation of Pompeii and Herculaneum. Howel Williams's story of Mount Mazama is, of course, a geological novel, written by an author who has felt at liberty to clothe the essential facts of research in trappings of make-believe so transparent that they can be trusted to deceive no intelligent student.

The second part of the booklet marks, as Rastall has recently pointed out in the *Geological Magazine*, a reversion to the procedure of Plato's dialogue. A Guide is beset with every type of question that might occur to an inquisitive visitor. I agree with Rastall that the ordeal is handled very successfully.

Here is the main theme: the caldera which holds Crater Lake, six miles in diameter, obviously replaces the central portion of the volcanic peak to which the name Mount Mazama has come to be attached in geological literature. The old, old question arises: Has the replacement occurred through explosion or subsidence? The Guide supports with figures the verdict that has long been accepted, namely, that subsidence has been predominant. He estimates that 17 cubic miles of old volcano have disappeared; and in the volcanic ashes spread over the country at about the same time as the caldera formed he can only find 1½ cubic miles of fragments of old volcanic material.

Having decided that 15½ cubic miles of volcano have sunk in the process of caldera formation, the next main question is: How was room provided to receive the downfall? Here it must be understood that the old volcanic fragments just referred to are a minor feature in ashes consisting mainly of contemporaneously formed pumice. This latter has the following bulk composition expressed in cubic miles: 2 of crystals + 3 of glass + 5 of bubbles.

Neglecting the bubbles, the Guide concludes that the expulsion of this pumice made room for 5 only of the 15½ cubic miles of downfall. The remaining 10½ cubic miles he accommodates by postulating a sudden withdrawal of a corresponding volume of magma through injection into subterranean cracks.

From this distance, one is tempted to inquire whether it is justifiable to omit the enormous output of vapour in striking a volume-balance between expulsion and downfall. Admittedly the 5 cubic miles of bubbles owe most of their volume to reduction of pressure; but presumably they represent only a small fraction of the volatiles actually released.

Let us now take up another interesting point. The Guide is able to show that the pumice-ashes first of all fell like snow through the air to lie, as a comparatively thin sheet, indifferently on hill and dale; but that later outpourings of similar material rolled along the surface as glowing avalanches to choke valley bottoms in the Peléan style, which was first correctly interpreted in the West Indies by Flett and Tempest Anderson. The Guide quite convincingly bases his recognition of the glowing avalanche type upon the restriction of the material to valley bottoms. I remember, however, that in 1933, without the assistance of this criterion, which depends upon a survey of the district, I felt sure that I was looking, in one of these valleys, at a cooled representative of what had been a glowing avalanche, because it showed well-developed columnar jointing. A glowing avalanche is, after all, a close relation to a lava flow.

Still another point raised by the Guide concerns the texture of the widespread fallen ash. The material is definitely coarser at the top than at the bottom. The Guide deduces from this observation an increase of explosive violence during the eruption, thus permitting of carriage of bigger and bigger fragments high into the air. Again, at this distance from the evidence, one may ask whether a reverse inference is not preferable; whether in fact there was not in the initial stages so strong a blast of gas as to produce a finer spray of pumice than could be maintained later in the proceedings. On this alternative interpretation, the final boiling over of the glowing avalanches, which, by the way, carry the biggest fragments of all, would be a sign of still further failure of gas supply, not, as the Guide imagines, the culmination of a crescendo.

If space permitted, it would be possible to draw many apposite comparisons between Crater Lake and its ancient deeply eroded predecessors at Glen Coe, Ben Nevis and Mull. One obvious conclusion is that Mount Mazama may have sunk much more coherently than is suggested in the sections that illustrate this booklet.

Now for a last remark. The Guide shows that the glowing avalanches contain most of their crystals in their upper layers. This is a repetition of a condition found by Kennedy in certain composite lavas of Scotland, which, strongly porphyritic above, are non-porphyritic below. The inference in either instance is clear: the porphyritic material now at the top of the bed of ash (or lava, as the case may be) must, before extrusion, have underlain the accompanying non-porphyritic material in the volcanic pipe. The Guide is certainly justified in his interpretation of this relationship as evidence of settling under gravity.

In conclusion, I wish to thank the author and all concerned for a booklet in every way worthy of its great subject. Readers on turning to its pages will realize how inadequate is the present restricted notice.

E. B. BAILEY.

THE HISTORY OF SCIENCE

A History of Science and its Relations with Philosophy and Religion

By Sir William Cecil Dampier. Third edition, revised and enlarged. Pp. xxiii+574. (Cambridge: At the University Press, 1942.) 25*s*. net.

SIR WILLIAM DAMPIER is to be congratulated on the appearance of a third edition of his history of science. The first edition, published in 1929, was quickly sold out, a second appearing early the following year. This edition has long been out of print. For a large, rather expensive book, which scarcely appeals to specialists, which is no help in passing examinations, which, though meant for the general reader, will be tackled only by the tougher members of the species, this is most encouraging. It shows there is a genuine interest in the history of science. Indeed, since 1929 a great deal has been done on the subject. Dr. Sarton's monumental work is going ahead; the journal *Isis* has published much valuable material, and excellent studies of special subjects and special periods have appeared. However, here is a comprehensive view in a single volume that need fear no rival for many years to come.

Comparison of the first and the new edition shows that many passages have been revised and generally improved. To avoid altering the numbering of the pages passages have also been omitted, and a few of these are perhaps to be regretted. There are many new citations of literature which greatly increase its value as a work of reference. A new chapter, the eleventh, has been added to record the scientific advances of the period 1930–1940. Many readers will turn to this first and most unfairly judge the book by it. It does seem a bit scrappy to read; it could scarcely be otherwise. The only alternative to this chapter would have been a complete rearrangement and almost complete re-writing of more than a hundred pages, and those probably the hardest to write. In any subject the nearer the historian comes to his own day the harder it is to be comprehensive and judicial. In science, where the rate of discovery in many branches in the years between the wars was becoming breathless, the difficulties are appalling. It is safe to predict that almost anybody reading this last chapter will conclude that his own pet subject scarcely gets its fair share and that certain subtle points have been dealt with rather crudely, but that other subjects are treated very fairly or even get more attention than they deserve.

The first thirty years of the twentieth century were the most spectacular in the whole history of science. The fourth decade did not appear so spectacular, but who knows what is to come? True, what Sir William Dampier has to record is mainly steady progress in many branches and no startling revolutions. The sky is clear, but the barometer is not steady. In biology none of the old controversies are really settled. Detailed knowledge accumulates, too fast almost, but general principles are lacking. In physics it is much the same. Physical theory, if the outsider may venture a remark, goes from bad to worse. There used to be one fundamental simplicity to cling to, namely only two ultimate, permanent, massive entities, electrons and protons (with photons as additional honorary members). One seemed to understand how these were necessary and sufficient. Now there are admitted to be several more, there is no apparent reason against any number of ultimate entities, and they are not so permanent after all.

Classical mechanics was the outcome of studying a narrow range of velocities and magnitudes (the moon and the apple.) By this over-simplification of the problem it succeeded in finding simple and useful working rules, but anything like a complete solution meant considering also the very fast, the very small and the very large. So also, in studying the general problem of the nature of matter, classical physics and chemistry were confined to a very narrow, easily accessible range of conditions and found useful but complex, numerous and ill-co-ordinated working rules. Twentieth-century physics, by going outside this range and investigating intense electric fields, extremely low densities, extremely high densities, extremes of temperature, and so on, has obtained much wider understanding and simpler generalizations; but it is pretty clear that nothing like finality has yet been reached.

The mathematics of physical theory always made it too difficult for the outsider to understand properly, but he used to comfort himself with the thought that the experts were agreed and therefore must be supposed to know. Now even this comfort seems to have gone. Moreover suggestions that some or all of the fundamental laws of physics are *a priori* seem to be gaining ground. Strong objections have been made to this notion, but the objectors do not seem very clear why they object. To work out a completely deductive cosmological theory is evidently possible in principle; it only needs brains. At least one empirical generalization would be necessary before it could be applied, but there seems to be no inherent reason, apart from imperfections in the theory, why there should be more than one. After that all the rest would be *a priori*.

If doubts and difficulties and unsolved problems accumulate, that is no reason to despair of science. Anyone who does despair and longs for the lost infallibility of the nineteenth century is making the false assumption that the material universe is such a paltry affair that a mere twenty-six centuries of intermittent investigation is enough to get to the bottom of it. This appears to be one of the morals to be drawn from the history of science. The other seems to be that, though no problem is finally completely solved, ingenuity and hard work can produce solutions that are valid within limits and within those limits a permanent gain. A. D. RITCHIE.

APPLICATION OF SCIENCE TO HUMAN NEEDS

Scientists Face the World of 1942

Essays by Karl T. Compton, Robert W. Trullinger, Vannevar Bush. (Rutgers University, Publications of the 175th Anniversary Celebration, No. 3.) Pp. vi+80. (New Brunswick, N. J.: Rutgers University Press, 1942.) 1.25 dollars.

THIS small book consists of three essays by Karl T. Compton, Vannevar Bush and Robert W. Trullinger, and three commentaries on these essays by Harvey N. Davies, Detlev Bronk and S. W. Fletcher. Although Dr. Bush relates his contribution primarily to the biological and Dr. Trullinger to the agricultural aspects of scientific development, the theme of each of the essays is the problem of how best to apply the enormous accumulation of scientific information in an economic manner to meet human needs and desires.

Dr. Compton discusses the progress which has been made in the fundamental sciences of physics, chemistry and biology and in certain of the applied sciences, and relates the extent to which it has been necessary to discontinue work in these fields in favour of investigations bearing more directly on the prosecution of the war effort. This is directing the attention of large numbers of men of science both in Great Britain and the United States to the sort of problems which confront the engineer acting in his normal capacity, and the benefit will be of long standing. These men of science are contributing to the development of new engineering tools such as special types of thermionic valves, alloys, plastics, etc., and their influence will accelerate considerably the already established trend away from the empirical towards the analytical approach to the solution of engineering problems.

The most interesting feature of the essays is, however, the broader use of the title of engineer than has been accepted as yet in Great Britain. The agricultural engineer discussed by Dr. Trullinger is by no means unknown in Great Britain, but even if the biological engineer, whose function is described by Dr. Bush, has been conceived, one has not heard of the introduction or consideration of the special courses of study which are evidently being contemplated in the United States. Whether we shall consider it necessary in due course to make special provisions for the training of those men whose function it will be, according to Dr. Bush, to supervise and control the application of the results of scientific research and the products of technical development to the biological aspects of the food, fermentation and clothing industries, sanitation, housing and medicine is uncertain. Whether we should call him a biological engineer is doubtful. We have accepted the chemical engineer, however, to advantage and at least we should avoid lagging unduly in our consideration of the needs in question.

The comparison with chemical engineer presented by Dr. Bush covers a point which it will be well to keep in mind from the beginning. He says: "When the chemical industry first began its phenomenal growth in this country there were primarily two types of professional men involved, chemists who manipulated test tubes and retorts in laboratories, and mechanical engineers who built and operated pumps and tanks in plants. What more natural than to create chemical engineers by giving them a scanty chemical training, and an equally scanty training in mechanical engineering ? The result was not a happy one, and it was not improved until a group of men, notably William Walker, created a new philosophy for chemical engineering based on the concept of the unit process. The chemical engineer of to-day is a far different individual from a mere hybrid chemist-mechanical engineer; he has a whole approach and a set of thought processes which are uniquely his. He differs from the chemist in much the same way that the electrical engineer differs from the applied physicist, and he has avoided being superficial in two subjects by creating a third in which he can be decidedly thorough.

"Much the same sort of evolutionary procedure is to be expected as the profession of the biological engineer develops. He does not need to attempt to create a new approach to the science of biology, nor does he need to essay a novel recast of the economics of business practice. He very much needs to produce a unique handling, at the professional level, of the combination of applied biology and its practice in industry."

Dr. Bush's essay does not leave one with a very clear picture of the intended function of the biological engineer and of the precise nature of the education and training he should receive. He says, however: "the engineer who designs and builds a plant in which a wide range of chemicals are produced and processed by biological methods will need to know something of bacteriology, of molds, of fungi, something of chemistry, a bit about energy transformations, perhaps some thermodynamics, and a good deal of mechanics. It would not be at all surprising, the way things are going, if he would need to know something of electronics. He will not be a master of all these, and if he attempts to become thus omniscient he will defeat his own purpose. He can, however, learn the entrances and how to go further."

It seems that special courses of study for agricultural engineers are available in forty-eight land-grant institutions. In the opinion of S. W. Fletcher, however, few of these have developed as yet "a distinctive curriculum having a characteristic core of studies" and he echoes views now obtaining wide acceptance in Great Britain in similar connexions when he writes:

"Here is the primary reason why so many graduates in agricultural engineering fail to meet the stern requirements of industry. It is common observation that those who have had adequate training in basic subjects with a moderate amount of training in specialised techniques are better able to adapt themselves to the constantly shifting requirements of agriculture and industry than graduates of highly specialized curricula."

"The charter of the land-grant institutions sets as their goal 'a liberal as well as a practical education'. A liberal education is defined by the Society for the Promotion of Engineering Education as 'The knowledge and practice of those intellectual pursuits, principles of living, and avocations which tend to broaden human interest and sympathies and to contribute to personal happiness and social welfare'. The public has a right to expect that graduates in agricultural engineering will be more than good technicians." WILLIS JACKSON.

WORLD AFFAIRS

Out of the Ashes

A Survey of the Unhappy Lands and a Design for International Harmony. By Thorburn Muirhead. Pp. 231. (London: Robert Hale, Ltd., 1941.) 10s. 6d. net.

THIS is the first attempt to put together the state of the world, after the Russian war but not including the Japanese. It is mainly a sketch of the British Empire, and is useful as showing the universal vigour of the island conquerors as soon as they took up the trail in the sixteenth century. It becomes an empire, and conquest was involved, but there was never any idea of world dominion. Trade, profit, adventure and the settlement of the New World led Great Britain by the end of the nineteenth century to be the premier Power in the world and an object of offence to other great Powers. *Hinc illæ lacrimæ*. With our earlier rivals—the French—a sensible agreement was made which at the moment is responsible for our command in Egypt and Suez. But the later rival was only piqued by jealousy of Great Britain. There was always a grasping and hectoring tone in Prussianized Germany, and in the Nazi regime that temper has been aggravated by the foulest stream of cruelty and lying which history relates.

The result is that, with the exception of Japan, all the threatened and occupied nations rally to the champions of world freedom. But they are at the moment helpless and the United States of America, the U.S.S.R. and Great Britain have to face the threat and restore the world.

Here Mr. Muirhead is favourable to us, though earlier in his book one might think a British conqueror or settler no better than he should be. Clearly the settlement of stronger people among the uncivilized must lead to friction. But an honest narration of the facts makes it clear that Britain civilized, and is far the best colonizer in the world. The Dutch have worked well with us in the now most contested part of the front.

Mr. Muirhead is quite clear that we shall win, or at least that Germany must lose: "the financial and economic scales are too heavily loaded" against her. But the task before us—perhaps for some years—is the restoration of order when the Nazi chain is broken. For this purpose the Atlantic Charter strikes the note. In the post-war world there must be some international authority, and Mr. Muirhead would be content if we did the policing. He sketches a scheme of free-trade roads which would enable the smaller nations to trade and to gain their own necessities without the loss and vexation which attend the present system. We wish such a plan well, but before that we have to break the hideous yoke which has been imposed by the Nazis until they reached the barrier of Russia.

It is a long and determined struggle and we need to keep something of the crusader, with all the fire and finish of modern war. It is to be hoped and believed that the United Nations will perform it.

F. S. MARVIN.

THE 'CELLULOSE AGE'

An Introduction to the Chemistry of Cellulose

By J. T. Marsh and Dr. F. C. Wood. Second edition. Pp. xv+512+24 plates. (London: Chapman and Hall, Ltd., 1942.) 28*s*. net.

THE influence of chemical research on the industrial applications of cellulose has in general been slow in making itself felt as compared with results in many other industries. This, perhaps, is due partly to the fact that the cellulose industries have hitherto been regarded primarily as the domain of the engineer; although a contributory and more likely reason is the complexity of the chemistry of cellulose. It is not surprising, therefore, that the important advances in this branch of chemistry which have taken place during the past twenty-five years are putting cellulose on an entirely new footing as a material of industry, and it may well be that the post-war period will herald a 'cellulose age' marked by many varied and interesting developments of a chemical rather than engineering nature.

Several weighty arguments justify this view. First, as Cross and Bevan wrote in 1895, "cellulose is the predominating constituent of plant tissues, and may be shortly described as the structural basis of the vegetable world". The industrial applications of cellulose are therefore, like agriculture, a direct link between man and the plant world. Secondly, the achievements and possibilities of the cellulose industries are impressive in both magnitude and scope. Thus what may be described as the primary cellulose industries, such as timber, textiles (including rayon) and paper, are all essential features of modern civilization, as war-time shortages have demonstrated only too well; while the secondary industries and their ramifications, though still in their infancy, cover an extremely wide field ranging, for example, from the plastics, fine chemicals and organic solvents derived from the waste liquors of the cellulose pulping processes, to the explosives, cattle fodders, sugars and other fermentation products obtainable directly from cellulose itself. There are many other examples.

It is not to be inferred that this volume covers all the fields indicated above; that it should result in reflections of this nature, however, is a measure of the importance of its subject and of the success of the authors, as well as the fullest justification for its existence—if justification is needed for a second edition which appears within three years of the first. The authors certainly have again done their work very well and have presented an up-to-date résumé of the subject, despite the great handicap of the rapid development of our knowledge in this field. This handicap is strongly apparent when, for example, the molecular weight of cellulose is considered; six different methods of determination are described, but the values obtained show marked variations, and this applies both to cellulose from the same source and to the results of different workers using the same method.

In this connexion there are occasions when the reader feels that he would like a little more critical comment from the authors themselves on contradictory results rather than bald statements, however accurate and concise, of the work of others; this is important in a book dealing with such a difficult subject, and intended (as the preface states) primarily as a guide to the younger chemist entering the cellulose industries. On the other hand, if the book is judged mainly for its value as a summary of current knowledge on the subject, it is impossible to praise it too highly. Little work of importance has been overlooked, and some of the few omissions (such as the convenient cupri-ethylene diamine reagent for the determination of the viscosity of cellulose) are probably the result of the long time-lag between publication and 'publicity' which exists at present.

Those who, like the reviewer, incline to the wider view of the importance of cellulose will be a little disappointed at the bias shown towards textiles, and in particular to cotton cellulose. Thus, for example, wood pulp (which may contain more α-cellulose than cotton and is the basic material of large sections of the rayon and paper industries) receives little mention, and then only in passing. Again, while the chemical and physical properties of cellulose are fully discussed, the effects on these of mechanical action (such as the beating operation in paper manufacture) are not referred to; yet they make valuable contributions to problems such as the structure of cellulose fibres, including those of textile origin. A chapter dealing with this very important aspect of the subject would certainly be a valuable feature of future editions. This, however, is a personal opinion, arising possibly from an opposite bias to that of the authors, and it in no way precludes the reviewer from confidently recommending the book to all concerned with cellulose as well as to the 'ordinary' chemist.

It is necessary only to add that apart from the discussion of the constitution and structure of cellulose at an earlier stage, the general scope and arrangement of the material are the same as those of the first edition. There are, however, some eighty additional pages and several extra illustrations. Misprints noted in the first edition have been corrected, but a few more have crept in, and some of the abbreviations used for references (for example, B.C.I.R.A. and J.T.I.) will probably be meaningless to many readers and do not occur in the explanatory list at the end of the book. The standard of production shows very little deterioration from that of pre-war times.

JULIUS GRANT.

Tin Solders

A Modern Study of the Properties of Tin Solders and Soldered Joints. By S. J. Nightingale. (Research Monograph No. 1.) Second edition, revised with inclusions of Results of more Recent Research, by Dr. O. F. Hudson. Pp. 118. (London: British Non-ferrous Metals Research Association, 1942.) 10*s*. 6*d*.

OF all the common alloys used by the engineer, solder is by far the most expensive. Further, as a result of the temporary loss of the main tin-producing area in the Empire, the utmost economy in the utilization of this metal, an essential ingredient in most solders, is imperative. The present time is, therefore, particularly appropriate for the publication of a second edition of a valuable little compilation which has been out of print for some time.

In its new form, this volume contains considerably more information than did the first edition, particularly in connexion with the metallography and properties of these alloys, and it speaks well for the excellence of the first edition that the part which deals with the more practical considerations and the choice of a suitable solder has required practically no modification.

As one example of the utility of this book, both from the point of view of the information it gives, as well as from that of economy of tin, may be instanced the solder used for production of wiped joints in electric cable sheathing. An earlier specification for such material required about 35 per cent of tin with not more than 0·5 per cent of antimony. It has now been found that an alloy with 30–31 per cent of tin which may contain up to 6 per cent of antimony has superior mechanical properties, gives joints of reduced porosity, and, in the experience of the workers, is easier to manipulate.

Dr. O. F. Hudson, the new editor, and the publishers have done a very useful piece of work.

A Supplement to the Yorkshire Floras

By the late F. Arnold Lees. Edited by C. A. Cheetham and Dr. W. A. Sledge. Pp. v+134. (London and Hull: A. Brown and Sons, Ltd., n.d.) 6*s*. net.

THE flora of Yorkshire has been described in the volumes on West Yorkshire by F. A. Lees (1888), East Yorkshire by J. F. Robinson (1902) and North Yorkshire by J. G. Baker (1906). Some thirty years ago, Lees collected the additional records and incorporated them in a manuscript entitled the "Vegetation of Yorkshire and Supplement to the Floras of York". This extensive manuscript included, however, so much theoretical discussion relative to the facts embodied that sufficient support could not be found for its publication, though the Yorkshire Naturalists' Union always hoped that the included records might be made available for botanists. This undertaking has now been achieved by Mr. Cheetham and Dr. Sledge and published under the auspices of the Union.

Mr. Cheetham has a very wide knowledge of the flora and has been connected for so long with all aspects of the work of the Union that no one could have been found better able to undertake the work of extracting all reliable data from Lees's manuscript and from the records of the Union. Dr. Sledge has added very many recent records and has revised all the material in the light of the most recent developments in nomenclature and grouping of genera. The volume includes a complete list of the recorded species, including aliens, casuals and escapes which are distinguished typographically from natives, with new recorded localities and points of interest concerning changes in distribution. This cheap and relatively small volume does great credit to the amount of work put into its preparation in order to condense the material to valuable essentials.

The Observer's Book on Astro-Navigation

By Flight-Lieut. Francis Chichester. Part 4. (Observer's Books, No. 5.) Pp. 152. (London: George Allen and Unwin, Ltd., 1942.) 4*s*. 6*d*. net.

IN this, the fourth and concluding portion of Flight-Lieut. Chichester's book on astro-navigation, a number of important matters are dealt with. These include a description of the flying-boat sextant and the errors that can be introduced into the observations by flight accelerations. The advantage of taking a number of observations at short regular intervals is shown and a brief description is given of the median-marking sextant. The aid to navigation given by running down a position line, when the sun is the only object available for observation, is illustrated by the record of observations on an actual flight; the method is of special value for flights over the sea, where no landmarks are available for fixing position. The important subject of curved flight corrections is dealt with in some detail. If accurate navigation is required, it is essential to apply corrections for curved flight, due to the rotation of the earth, or to the course steered not being a great circle, or to gyro-wandering. The account of these corrections is somewhat confused, though the method of applying them is clearly explained and illustrated by examples.

The four parts of this book together provide a useful summary of the principles and methods of astro-navigation. Written by a skilled navigator, they contain many practical hints, and any navigator who has mastered their contents cannot fail to benefit from them.

H. S. J.

The Subject Index to Periodicals, 1940

Pp. xi+230. (London: The Library Association, 1942.) £3 17*s*.

THE Subject Index of Periodicals, 1940, issued by the Library Association, publication of which has been considerably delayed by enemy action, covers 534 periodicals, other than those, with some important exceptions, covered by the *Agricultural Index*, *Engineering Abstracts*, *Engineering Index*, *Index Medicus*, *Journal of the Society of Dyers and Colourists*, *Photographic Abstracts*, *Bibliography of the Royal Meteorological Society*, *Science Abstracts*, *Journal of the Textile Institute*, and the *Revue des Géologie, Minéralogie et Crystallographie*. The number of entries has been diminished owing to the curtailment of the supply of Continental periodicals since 1940, and some of the files of American periodicals are also incomplete. The volume, however, is only about one sixth thinner than the normal volume. The Index is compiled on the plan of the dictionary catalogue, articles being entered under specific headings, in alphabetical order. Explanatory matter is added in square brackets where the titles do not sufficiently indicate the subject of articles. Since September 1940, the editor and his staff have been accommodated in the National Library of Wales, Aberystwyth, although part of the work still has to be done in the British Museum Library.

MORALE

By JOSEPH GEOGHEGAN

"If thy people go out to battle against their enemy."
1 Kings, 8, 44.

MORALE is a feeling of confidence and competence in the conduct of an enterprise.

This definition needs some enlargement. Morale is a feeling, an emotional state, not an intellectual opinion, and is thus like all emotions a variable; it can be either good or bad. It is a feeling of confidence, confidence in the outcome, confidence in cause, comrades and leaders. It includes a feeling of competence, of personal capability, self-confidence, if you wish. Lastly, morale requires a positive issue, relatively a major one, for the term has no bearing in situations without such an appeal.

Application of the word may properly be made to an individual or to an aggregate of individuals. The latter, however, must possess one definite characteristic, that of being homogeneous in the sense of free association, purpose and sympathy, as in a street crowd, a regiment or a nation. The purport of the following remarks is intended to consider more particularly aspects of morale in the case of the last.

It is important at the outset to recognize clearly that the motivations of a crowd differ radically from those of an individual. The herd instinct, a very strong one, has to be taken into account. While this is active at all times to a slight extent, encouraging behaviour in harmony and consistence with the welfare and custom of the community, it can become, and indeed would appear to be so constructed as to be capable of becoming, a paramount feeling. This is particularly the case in the presence of danger. The ranks close up, there is a reduction of personal individuality, the unicellular organism has, as it were, become part of a multicellular whole.

Furthermore, this effect brings about a reversion to impulse and action of a more primitive type, more of a childish pattern, more of the deeper mind-stuff, the unconscious. The mechanism involved is interesting and pertinent to the issue. The herd instinct operates by an intensive heightening of the suggestibility of all the component units, the people in the crowd. This feature requires emphasis. Suggestibility is definitely outside or beyond the control of the individual and is not necessarily agreeable in any sense with his own interests. It is a simple sharp response immediate and direct to the stimulus of the moment, akin perhaps to a conditioned reflex. The strength of suggestion in a group is very strong; the individual has little or no option but to obey, for it is the emotional side which is employed, not the rational. When the individual merges in the mass his rational mind sinks with him; he ceases to be himself. It is a waste of words to appeal to the intelligence of a crowd; it is only their emotions that listen.

Arising out of, and indeed a component part of, the instinct of the herd is the need of leadership. The pack at all times demands a strong dominant personality in front; in the presence of trial or danger the need becomes insistent and incidentally much more decisive. We then feel the rightness of the right man in the right place with a confidence past question.

With the leader the members of the herd feel a strong identification; he exemplifies in himself the genius of the pack, something louder, coarser, bigger, but something utterly and vividly the presentment of each and everyone. His qualifications are curious; he need have served no long apprenticeship, he need have no particular intellect, but he must have personality and character. He must have the prestige which follows not the reality of achievement but the appearance of it. Finally, he must still be the common man, like the wolf leader, only one jump ahead of the rest. All the members want to see clearly in front the visible embodiment of their own feelings.

After these brief references to certain aspects of the basic material, the factors influencing morale may be considered. Both the physical and psychological sides are involved but the effects of the former are more evident in a detrimental sense.

Factors Tending to Increase Morale

Bearing in mind that morale refers to an emotional tone, the first and probably the most important factor tending to improve confidence and competence in the conduct of an enterprise is *the sense of unity* engendered by the increased contact with our fellowmen, the closing of the ranks. This has both its physical and psychological sides and indeed they are very closely intermingled. In ordinary civil life man is gregarious only in a narrow range, in his work, profession, game, club and so on; in times of danger or distress the need for support, the strength in unity, and vice versa, the insecurity of isolation, converge. They encourage the need for the company of our fellow creatures by the bond created in a renewed community of interest. This fresh warmth of feeling again fortifies courage and fills the individual with a new and special strength. It is the heightening of this impulse which leads to a notable breakdown of social distinctions and local prejudices. Comradeship and the team-spirit are the visible evidence of a common purpose. There is a strong exaltation of both the patriotic and the human sides, all the more so when the combative and aggressive feelings are allowed approved outlet in identification with a greater whole.

This sense of fulfilment in unity gives a new steadfastness and energy to each member of the pack; it increases altruism and tends to add a moral strength to morale. For the national interests so obviously link up with the highest moral aims and purposes of humanity. They are thus strengthened by the indirect appeal to the noblest aspirations of the individual, the conviction of a righteous purpose, the strong association of duty with a deep religious feeling. These feelings may be consciously enhanced by the deliberate inculcation of a high moral aim, by the 'indoctrination' of the public in a sacred fellowship, by the stress laid upon a positive ideal which directly relates national need with a spiritual purpose.

Conversely, the enemy personifies all evil. The same instinct of the herd that brings the ranks shoulder to shoulder for the common good, that gains strength with every fresh evidence of national righteousness, vehemently denies to the enemy any shred of justification. He so blatantly represents the negation of all good, he so deliberately runs counter to every law of God or man, he carries with him such a foul string of barbarities that it becomes only right and proper to smite him hip and thigh. Old Testament phrases come readily to the tongue to express the feeling.

The groundwork for this sense of unity will have been prepared not only by education in the young in the geography and history of their native land, but also by the cultivation of a political philosophy that brings the genius of the nation into the closest relations with the highest ethical principles. Self-defence is not enough, it is too negative; there should have been a long and careful preparation tending to dignify the responsibilities, nay the duties, of the nation with a positive, a moral goal. Phrases such as "England, My England", "this blessed plot, this earth, this realm, this England", the white man's burden, the commonwealth of nations, and so on, become eventually part and parcel of everyday thought, and are accepted as self-evident truisms. It will not, of course, be overlooked that this attitude is by no means the sole prerogative of any one nation; an identical purpose is apparent in the use of such words as Aryan, superman, *Herrenvolk*, *Lebensraum*, etc. The principle has very general application.

Second to this sentiment of unity comes the feeling of *confidence*. This includes many of the relationships of the herd animal, notably so when herd consciousness is stimulated afresh in time of trial. Certain aspects stand out: these are cause, comrades, leaders and equipment.

Confidence in the cause wherein all are engaged implies two angles of approach: confidence in its essential rightness and confidence in its result. The first depends largely upon the depth of that intense emotional feeling we call patriotism; this again arises from a continuity of effects which may be summarized as nature and nurture, which co-operate to encourage the sense of nationality. The famous lines beginning "Breathes there a man with soul so dead" may be recalled to illustrate the passionate association of patriotism with what is regarded as the highest side of mankind. Conversely, from the very strength and urgency of this feeling springs the sharp resentment at the insolence of alien attack. "Ourselves alone!"

This sense of nationality, this patriotism, wells up 'as it were' under pressure from great depths; it is a trained and disciplined emotion, partaking of a certain splendour and assured of a genuine approval. The ground has been prepared not in one but in many generations and needs but a touch to set it all aglow with faith in the right and in the result. Then speaks in no hesitating voice confidence in the high abiding virtue of our cause and the sweet certainty of success. It may again be remarked that there is no material difference between the feeling in Moscow, Madrid, Manchester or Munich.

Confidence is also felt in comrades. This will be at once enhanced by the direct recognition of an equality of service and an equality of sacrifice. The positive evidence of mutual resolve and support, the visible activity on the part of everyone around to the same great purpose, all for one and one for all, encourages the feeling of comradeship and co-operation, which again reacts to strengthen personal endeavour: "Duke's son, cook's son, son of a millionaire" and so on. In service alone can be found peace and satisfaction; if it be denied, discouragement, anxiety and restlessness are felt.

But an equality of sacrifice plays an equal part. The press of conscription on everyone, the fracture of all social distinctions in the ranks, the subordination of the individual pattern in the need to keep step, the acknowledged severity of an income tax that strikes at incomes not at wages, and perhaps most real of all, the daily lists of casualties—names from both the castle and the cottage—bring out afresh mutual trust and *esprit de corps*. Everyone can do his bit!

Confidence must further be felt in leaders and equipment. It will be at once understood that the multiple millions of a modern nation need not a leader, but leaders. There will be many graduations of place and post, all of which have weight and effect. Selection on the part of any section of the public, if allowed free play, will be spontaneous and accurate; it will be natural and will choose a natural leader. Conversely, the capacity to select efficient deputies must be one of the cardinal qualities of leadership.

Equipment again can have decided influence on confidence. The recognition of efficiency to our personal knowledge in the tools to hand, not only the ones *I* use but the ones *we* use, at once improves confidence in every sense. The dark silence of the Navy in the North Sea, the swift and generous issue of gas-masks and the sudden surprise of balloons over London, all had immediate and heartening effect. Like the symbol of the 'tin hat' or the realization of the tremendous technical resources of the United States behind us, they offer additional justification for confidence.

Confidence further extends to the individual in relation to himself and may then be more properly described as a feeling of *competence*, competence in his own conduct in the enterprise. Self-respect and self-esteem at once improve with the search for the personal share, by the genuine attempt to take up and perform serious and important tasks and in particular by their co-ordination with a common effort. Personal ambition is thus brought into the closest association with comrades and country, strengthened by the conviction of moral rectitude, and is directly linked up with the call of duty. This again reacts to strengthen the sense of responsibility and capability which are enobled by self-approval, encouraging the fullest realization of the self in complete alignment with the realization of society.

The personal side is directly increased by the new feeling of place and position, by news in the exploits of one's own or associated groups, by the exaltation of personal bravery and courage, by the evident approval of public opinion and senior officers, by promotion, real or anticipated, by pride in uniform and equipment, by new surroundings wherein one starts as it were from scratch, by the close feeling of linkage with the nobler episodes of national history, and last but not least by the increased and obvious admiration of the other sex.

All three factors tending to increase morale intimately interact. The increased sense of unity with one's fellow-men, the team-spirit of mutual effort, confidence in the righteousness of our cause and the certainty of the outcome, and the fresh zeal of personal ambition, combine to stimulate a high and ardent spirit in the common man.

Factors Tending to Decrease Morale

Interest in the subject of morale has come sharply to the for elargely by reason of the quantity and quality of the numbers actually involved in the conflict. For practical purposes the exposure to, indeed the frequent reality of bombing, turns everyone into a combatant—worse than that, a combatant deprived of the reasonable outlet of an aggressive reply; this involves a high degree of strain. Besides the quantity, the crude mass of people thrust willy-nilly into this affair, the quality is poor. It is poor in the sense that there has been no calculated preparation for the occasion, none of that assiduous training of both emotion and intellect whereby is created the disciplined unity of the soldier. It is very doubtful if deliberate effort in that direction could be made practicable; more than that it is still more doubtful if it could succeed. The Germans have made attempts by the training of youth and by the distribution of trained agents, but their methods are questionable and their assessment must await future consideration.

Again, the press of warfare fell formerly on a selected portion of the population, selected in age and physique, whose aggressive combative feelings were deliberately led towards an optimum outlet. War took on then for the ordinary adventurous youngster a very satisfactory appeal; it became rather a great game, the greatest of games. But this can no longer describe the situation to-day. 'Total war' has thrust dirty fingers deep into the intimate consciousness of almost every human being, often with a quick sense of acute personal danger. Moreover, it is no longer a short sharp shock calling for gallant bearing, courage and dash; it has become a vehement and prolonged period of tension demanding the deliberate cultivation of a savage resolve.

These are not the days of petty personal vicissitude but of a great upheaval involving directly the selected purposes of humanity. The strain has to be borne by the common man and woman, by loose masses of humanity half developed, half educated, anxious and insecure. Tension so widespread, so severe, so unfair, has brought sharply to the fore visible and unpredictable stresses. It is indeed time to consider and to cultivate morale.

The most important factor tending to reduce morale is a state of *chronic fatigue*. The term is not intended to be used in any restricted sense but is employed to indicate that all-round deterioration of well-being which is brought about by prolonged under-nutrition, by continued insufficiency in the quantity of food and in its quality. Mere bulk of food in no way compensates for a lack of balance and proportion in its components, particularly as regards its freshness. A similar result, though slower in production and less in effect, follows upon long hours of wearisome labour, insufficient or broken sleep, bad housing, bad cooking, bad ventilation. Of these, states of nutrition are the most important for our present purpose. Reference is, of course, intended rather to effects on large masses of the population than in an individual sense, though the latter is more quickly evident and understood.

Adequate, sufficient and satisfactory food is a prime necessity to everyone; a decent meal makes all the difference. Chronic under-nutrition saps the vitality and reduces physical and nervous tone and resistance in a manner akin to prolonged ill-health. It does more; by its appeal to very elementary instincts and needs it creates an urgency tending to override all other considerations. Bread becomes more important than victory; a hungry man will walk up to a machine-gun. Nutrition is further impaired by the other detrimental conditions mentioned. They may be commonplace enough but their incidence is increased in war-time. Their supplementary influence will be readily understood. The consequent ill-effects will be aggravated by psychological conditions encouraging discontent, the blatant evidence of waste, waste in every sense of material and effort, misdirection, reduplication, bad management, personal frictions, distrust and ridicule. But it is probable that the merely physical has the more lasting and more severe effect.

Fear is another important factor causing deterioration of morale. It is related to fatigue, but the former tends to be primary; in states of chronic fatigue fear will the more readily arise, but states of fear do not produce the same fatigue effects.

Conditions responsible for fear in one form or another are, of course, manifold, but there is one the importance of which cannot be over-rated; this is isolation. Under strain and stress swiftly follows an intolerance of solitude, physical or mental. The need of the mere physical contact with our fellow-men is very urgent, and if frustrated or hampered brings about restlessness, impatience and anxiety. While this applies of course to the individual, it plays an important part in the group-mind. The knowledge of friends and allies who are near, able and willing to help, strengthens purpose and confidence by the feeling of support. Isolation, real or apparent, produces or aggravates manifestations of insecurity and impotence, and thereby sensitizes the fear-sense.

Fear has several forms; panic is a "gigantic and senseless dread", apprehension is a continuing anticipation of danger, and fright involves surprise or sudden shock. The effect of mere noise may be here remarked on; this is a primitive fear stimulus, evident in all the preliminaries or actualities of combat from the roar of the lion to the trumpets of a mighty host. The present War is unpleasantly noisy, though the stimulus would not appear to have been deliberately sought by either side. Another point which may be referred to is the production of acute states of fear or shock, the so-called 'shell-shock', and of chronic states of anxiety by continuous recurrence of slighter degrees of very genuine strain against which there is neither defence nor reply.

An index, useful as a rough guide to the extent of fear in a given population, is found in the prevalence of rumour. The stimulus of fear, not necessarily of danger, sensitizes the collective mind, so that an attitude arises swiftly credulous of information reinforcing and fortifying this emotional tone. The degree of fear, more particularly of apprehension, and conversely the degree of confidence, will be reflected in the prevalence or otherwise of rumour. No such situation arises, of course, unless the gravity of the threat be considerable, but that alone does not suffice, a heightening of fear must be added. The same attitude explains the unfounded suspicions of 'fifth column' influences recurrent in a timid, distrustful, over-anxious population. These indicators are worth watching. Apparent lack of progress, even news of serious setbacks, has little or no effect upon a population whose tone is good; for example, the reaction in England to the sinking of two battleships and the loss of an army in Singapore.

Inertia and depression manifest themselves as a result of monotony or inactivity. Just as privations lead to fatigue, and danger, real or imaginary, to fear, so the persistence of long wearisome hours, lack of interest, lack of variety, of change, bad weather conditions, night-work, black-out, home-sickness, distasteful associates, and in particular monotony, monotony which appears to serve no useful purpose, lead to a degradation of moral or physical energy which calls for special remark. There is a loss of sense of proportion, a pre-occupation with oneself, a lack of interest in and capacity for work, a depression of stamina.

Periods of inactivity, complete or partial, when circumstances refuse any reasonable outlet of energy, particularly useful energy, is another form of monotony having similar effect. It is important to recognize that change and variety of occupation and interest represent for human beings a form of rest, physical and mental. The Germans take this point seriously, encouraging frequent holidays and strenuous physical exertion on the part of higher officials.

As in the case of those tending to improve morale, factors of a deteriorating nature may well be multiple and indeed often are. They then tend to exaggerate the respective reactions. States of chronic fatigue from one cause or another clear the ground for fear and depression; conversely, situations likely to produce the latter will aggravate the unpleasant sensations of fatigue.

Conclusion

Morale, more particularly in its national aspects, requires serious attention. The problem in the case of the disciplined soldier is much easier, something concrete has been prepared to work on; it is a very different matter with the shifting unstable masses of a civil population exposed to novel and dangerous stresses. The strain is not merely physical; all sorts of real and imaginary threats hang darkly upon the horizon, stripping away ancient securities and landmarks.

It will not have escaped notice that some, at any rate, of the factors concerned with morale can be directly influenced by deliberate effort, by taking thought. Such effort need not solely derive from authoritative sources but should reasonably come within the province of every responsible person.

Both sides in this Second German War—this Second Punic War—have advantages and disadvantages. The stability and resolution of the Allies may be set against the plasticity and discipline of the Axis peoples. That on the whole the balance would appear to favour the former need not encourage neglect of a factor of increasing, perhaps ultimate, importance.

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WILD LIFE IN THE WESTERN HIGHLANDS*

By SETON GORDON, C.B.E.

THE War has little affected the Western Highlands. It has, of course, been in the favour of those animals and birds which are sometimes classed as vermin. But I think that this is a narrow-minded and repellent term, given by those whose lives were formerly devoted to the care (and then the destruction) of the red grouse.

This is the third early summer season that the Highland deerstalker and the Highland gamekeeper have been on 'active service', and the most noticeable result of this absence is the spread of the fox. The fox has now become a menace to crofters and sheep farmers in a number of West Highland districts. More than forty lambs were killed last spring near us in Skye.

The wild cat is also on the increase, although not to the extent that might have been imagined. A deerstalker wrote that he recently found the carcass of a wild cat at a golden eagle's eyrie. There must have been a great fight before the eagle was able to kill the cat—unless indeed the King of Birds had happened to come upon the cat asleep. I have visited many eyries of eagles, but I have never seen a wild cat brought as prey, although I have seen the remains of a stoat more than once. A deerstalker once described to me a tremendous onslaught by a golden eagle upon a wild cat. The eagle swooped on the cat thirty or forty times, with its great talons ready to grasp it. Once, as the eagle came very near, the cat sprang into the air, striking at the eagle with its claws. The spring was so great a one that the stalker saw the whole of the cat for a second suspended in mid-air.

During the month of May, some years ago, my wife and I had a 'hide' at a golden eagle's eyrie on a rock up a lonely glen. We stayed with the stalker in the only house in the glen, and from the stalker's house to the eyrie was a distance of two miles or more. There was a blackbird living near the stalker's lodge. One night my wife had taken an all-night watch in the hide. Eagles sleep very late (for birds) since there is no necessity for them to search for the early worm, and the birds and beasts on which they prey are not usually in evidence until the sun is well up. The blackbird had taken a flight far afield that morning, and before sunrise flew up and perched in the small rowan tree that grew beside the eyrie. Here he began to sing and his song awakened the sleeping eagle on the eyrie. The eagle aroused herself, and glared balefully at the blackbird, which at once flew off to more healthy surroundings.

In the West Highlands is a high cliff where a pair of eagles and a pair of ravens nest. It is astonishing how hard the eagles are mobbed by the ravens, which attack them in the air for half an hour at a time. The ravens have to fly at their topmost speed to keep in touch with the eagle during its downward swoop. The eagles very occasionally turn half-heartedly upon their persecutors, but for the most part treat the attacks with indifference. Only last week I saw this eagle attacked previously by a pair of kestrels. Upon occasion I have seen two eagles attacked in the air by a single raven. Golden eagles do not often nest on cliffs beside the sea. I have seen one eyrie in this site, and the ground at the head of the cliff was honeycombed with rabbit burrows, so that the eagles had not far to fly for food for the two eaglets in the eyrie.

Near that eagle's eyrie is a colony of fulmar petrels. In the British Isles the fulmar is increasing to a remarkable extent. In the year 1878 there was only one colony in Britain, and that was on distant St. Kilda, an island group lying some fifty miles west of the Outer Hebrides. Whether the surplus stock originated on St. Kilda itself it is impossible to say, but at the present day the fulmar nests along the coast of Sutherland and Wester Ross; it has established colonies upon Skye and the Outer Hebrides; upon Mull and the small islands lying to the west of Mull. From Mull, or perhaps from Barra Head, it has spread to

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[*] Substance of a lecture at the Royal Institution on May 29.

Eire, Wales, and even the coast of Cornwall. On the east side of Britain it has spread from the coast of Caithness, by way of Berwick, to Northumberland, and even to Yorkshire beyond. When it is realized that the fulmar lays only one egg in a season, and may not even lay each year, this increase is one of the most remarkable things in the history of British birds.

The common bumble bee is found throughout the West Highlands. It is a strong flier, and I have met with it crossing the summits of the Cuillin range in Skye. From personal observations I know that there is a flight-line of these bees between the mainland and the Isle of Skye across the Sound of Sleat, a distance of some five miles. From observations I believe there is also a flight line, in fine, calm weather, from Hunish, the most northerly point of Skye, across to Lewis, a distance of some twenty miles. Bumble bees are strong fliers and I remember only on one occasion seeing them defeated by the power of the wind. I was crossing a long line of cliffs in northern Skye and although the sun still shone the south-east wind was increasing to gale force. The wind struck the cliff, which threw the body of fast-moving air high into the sky. This proved an impassable barrier to the bees. Again and again they essayed to fly out over the cliff, and each time were tossed high into the air and swept back, to fall on the heather in the zone of relative quiet behind the cliff. Here bumble bees were to be seen crawling, exhausted, on the ground. The season was September, when the nights are long and cold, and I often wondered what the fate of these storm-beset bumble bees was.

WHAT THE PLANT DOES WITH ITS MATERIALS*

By DR. HUGH NICOL

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PLANTS build up a large variety of organic substances. The aromatic compounds of plants include several anthracene derivatives, such as the principles of madder and of senna, but scarcely any naphthalene compounds are known: vitamin K is one of these. Most of the organic constituents of plants are formed of carbon, hydrogen, oxygen, nitrogen, and occasionally phosphorus, sulphur and selenium. No organic halogen compounds have been found in the higher plants; there is no sound evidence that iodine or bromine is necessary for plants, nor is chlorine apparently essential.

In plants few types of organo-metallic derivatives have been extensively investigated; of these, chlorophyll is the best known. Phosphorus occurs in organic combination in phytin and some other substances. Calcium occurs as pectate and organically bound in agar, yet, generally speaking, the bases are best known in combination with simple organic acids. Iron is essential for plant growth, but beyond saying that it is indispensable for the production of chlorophyll, into the composition of which it does not enter, there is not much that can be said about its role in the plant; nor, except about a very few elements, can much be said regarding the combinations of elements in plants or about the function of their compounds.

Plants have been shown to require, for their proper development, minute amounts of what the agronomist calls 'trace' or 'minor' elements, meaning thereby elements which until recently were not regarded as necessary, or were even regarded as toxic. The list of necessary elements is now long and is growing. The success of grain formation in cereals grown on some copper-deficient soils of Australia depends upon the uptake by the plants of a few grams of copper per acre. Water from a copper still usually contains enough copper to be toxic if the water is employed for solution cultures; the essentiality of copper is thus a matter of micrograms rather than of milligrams per plant.

The discovery of boron as an essential element for many plants originated in the circumstance that at Rothamsted Experimental Station there was an entomologist who wished to make bean plants distasteful to the black 'fly' (aphis) which he was studying. The Botany Department supplied him with some formulæ for water-culture solutions to include several unusual elements of which boron was one. All his plants died except those which had been given boron. This was in 1921. The matter was looked into, and in 1923 Dr. Katherine Warington published the proof of the need of the broad bean for boron[1]. It is not given to everyone to found a minor industry with her first piece of research, yet this, in effect, happened in her case. Not only has the agricultural consumption of boron compounds attained considerable dimensions but also the importance of salts of copper, manganese, zinc and other elements as manurial constituents is increasing.

The necessity of zinc for pecan trees on the copper-deficient soils of Florida was discovered owing to a copper solution having been made in a galvanized bucket; only trees treated with this solution (which unintentionally contained zinc) responded[2]. An interesting effect of minor elements was also reported from Florida, where orange trees treated with minor elements in addition to the usual fertilizers suffered much less frost damage than did those receiving customary manuring. This offers an example of the dependence of 'condition' upon nutrition. Some minor elements are important for animals though not essential for the herbage plants, which function simply as vehicles. The uptake of cobalt offers an outstanding example of dependence of animals on the soil via the plant.

Plants can be selective in their uptake of elements. There is geochemical interest in the concentration of mesothorium by a pond plant[3]. From the point of view of essentiality and uptake, one of the most interesting elements is selenium. Its physiological role has been recognized only in the last decade, owing to the investigation of seleniferous soils. These soils have only a small selenium content, but cover vast areas in North America. Marco Polo recorded poisoning of animals in China which has since been shown to be referable to a seleniferous soil. A similar condition in Ireland remains unexplained[4].

In their reactions to selenium, plants can be divided into four groups: those which require selenium, those which can tolerate large amounts in their tissues, those which can tolerate small amounts but are poisoned by large amounts (these include crop plants such as wheat), and those which practically exclude it. The last group comprises some native prairie grasses. The first group is formed by some species of the botanically varied genera Astragalus, Oonopsis and Stanleya; for these selenium is an essential element, and the concentration in the dry matter and in the seed may surpass 3,000 parts per million. Recently an amino-acid complex containing both selenium and sulphur has been isolated from grain and from Astragalus[5].

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* Substance of a lecture given before the London and South-Eastern Counties Section of the Institute of Chemistry, at the Institute on April 15.

Plants for which selenium is essential, such as certain species of Astragalus, will, of course, grow naturally only on seleniferous soils (the converse does not hold). Hence they serve as an interesting introduction to the subject of 'indicator' plants—that is, plants which by their presence or mode of growth indicate soil conditions. The medieval discovery of alum in Italy and the establishment of its manufacture as a Papal monopoly are said to have originated in the finding at Tolfa of a plant supposed to be the same as one which grew near the older alum mines of Asia Minor[6].

The plant's raw materials are all very simple chemically; unlike the animal, the plant is not adapted for the assimilation or digestion of complex foodstuffs, and if complex materials are presented to the plant they must first be broken down by bacterial or other action before the plant can take them in. The chief rôle of the soil is to serve as the nidus for such decompositions: weathering for the breakdown of minerals, biological decomposition for the breakdown of plant remains and other organic matter. An important product of decomposition both in the soil and in the tissues of living organisms is carbon dioxide. The only recognized sources of carbon dioxide and indeed of carbon for the plant are the atmospheres above and in the soil.

Pliny referred to the product of respiration as *spiritus letalis*, but it would be truer to call carbon dioxide *spiritus vitalis*. The application of radioactive tracer carbon has shown that reduction of carbon dioxide is a general property common to all living cells, and has led to revolutionary ideas regarding the mechanism of the photosynthesis of sugars in the insolated plant. The initial step in the assimilation of carbon dioxide by photosynthesizing cells is a dark process independent of light. The first intermediate in photosynthesis has been isolated and has been partially characterized as a large molecule of molecular weight about 1,000, having a free carboxyl group and an alpha hydroxyl group. This is supposed to be an enzyme or a prosthetic group of an enzyme and it reacts like this:

$$\mathrm{RH} + \mathrm{CO_2} = \mathrm{R\,COOH}: \text{ dark reaction,}$$

in which RH is the reduced enzyme group. The light reaction or photochemical step then occurs:

$$\mathrm{R\,COOH} + \mathrm{H_2O} \xrightarrow{\text{chlorophyll}} \mathrm{R\,CH_2OH} + \mathrm{O_2}$$

$\mathrm{R\,CH_2OH}$ adds another $\mathrm{CO_2}$ and the process is repeated to build up long carbohydrate chains[7]. Green plant photosynthesis is only a special case of the general biological phenomenon of dark carbon dioxide reduction.

All plants, even those inhabiting arid regions, are very wasteful of water. For every ton of grain or of dry matter produced, several hundred tons of water are passed through the plant and are discharged as vapour into the atmosphere. The remaining elements are mainly assimilated through the roots, though some for which the plant has only a small requirement can be absorbed through the leaves and stems. Plants are ionic feeders, and they need their ions as simple as possible.

That the plant is not a homogeneous absorbing system is shown by experiments with roots divided between nutrient solutions of differing composition, whereby corresponding differences are produced in the tops. Dr. John Caldwell has suggested that plants having decussate phyllotaxis lend themselves to neat demonstrations of this inhomogeneity, as when half the flowers of a hydrangea plant were red and the other half blue.

Asymmetry in absorption is well shown by the observation that swedes in the field develop better on the south side than on the north. Here are some averages, after Caldwell[8].

TABLE 1

RADII IN MILLIMETRES, OF QUADRANTS OF SWEDES

Rows running	N	S	E	W
E–W	49·5	58·5	50·9	59·5
N–S	44·5	50·8	46·5	49·5

This is due to differential assimilation by variously insolated leaves.

Intake of nutrients through roots takes place in three ways: direct absorption of anions and cations through the finer roots and root hairs; absorption or exchange of nitrogenous compounds from nodules attached to the roots of many leguminous plants; indirect absorption through the medium of fungi which together with the roots form what are known as mycorrhizæ. Recent knowledge about roots has given new perceptions about their extent[9]. T. K. Pavlychenko has measured the roots of single prairie grasses grown free from competition of other plants and has recorded more than three hundred miles of root belonging to a single plant three years old, while a single plant eighty days old had fifty-four miles of roots of first and second order alone. A young plant may have a net gain of the order of one mile of root daily. Roots are neither permanent, as a rule, nor static. The finer roots of a living plant are constantly being shed, and thus are taking part in the cycle of decomposition in the soil. W. S. Rogers[10] has demonstrated the impermanence of roots of such a substantial plant as an apple tree. Within a few weeks apple rootlets have been observed to grow and decay, fresh ones being formed meanwhile in the same region of soil.

There is a balance between the amount of root and the amount of top. By cutting the tops of a plant—say, by mowing the lawn—the roots are also trimmed. (Table 2.)

TABLE 2

DRY MATTER PRODUCTION, IN GRAMS, OF LUCERNE CUT AND NOT CUT[11]

Tops	July 6	July 27	Aug. 24
Unclipped	10·4	17·7	20·4
Clipped once, July 5		18·5	
Clipped twice, July 5 and 26		(clippings	24·5 included)
Roots			
Unclipped	5·8	16·5	24·1
Tops clipped once		10·3	
Tops clipped twice			16·0

A closely cut lawn suffers during a drought because the diminished roots are not able to reach the soil moisture in the deeper layers.

Roots are not merely absorbing organs; they are also reserve organs. The relation between tops and roots has important practical consequences, since if perennial forage plants and grasses are cut or grazed too closely in late autumn they will not be in a good condition to survive the winter or to make early growth in spring, on account of the lack of sufficient reserves in the roots. Nitrogenous manures applied in spring are no substitute for adequate over-wintering root reserves.

Leguminous plants may possibly excrete nitrogen fixed by the aid of their associated nodule bacteria, and may thus act as nitrogen 'foster-mothers'. The dynamics of the plant include several modes of return of absorbed material to the soil. The most obvious in perennial plants is leaf-fall.

A more interesting mode of return of nutrients to the soil is apparently common to annuals and perennials. It is what the Rumanian worker N. T. Deleanu has called *Rückwanderung*. The demonstration of this process is not very simple with modern data, but the work of J. I. Pierre in the 'sixties is of interest[13]. Table 3 shows amounts of some elements present in the whole wheat plant.

TABLE 3

KILOGRAMS OF CONSTITUENTS IN A HECTARE OF WHEAT (WHOLE PLANT INCLUDING ROOTS). (AFTER J. I. PIERRE, 1863.)

	June 13	June 29	July 13	July 30 (harvest)
Total organic matter	5400	6500	6900	6800
N	76	76	68	70
SiO_2	191	252	214	228
Fe_2O_3 -	15	30	17	19
CaO	44	45	44	36
K_2O	39	55	34	34
P_2O_5	18	19	18	23
,, in ears	2	4	7	17

There is a maximum of richness a month before harvest; the only constituent that goes on increasing is phosphorus in the ear. While possibly some of the potassium is washed out by rain, it seems that part of the early stock of nutrients has been returned to the soil. Plants can absorb ions from true solution, but the soil solution theory is unable to account for *Rückwanderung* or for what has been called contact depletion.

The ideal soil is not composed of discrete mineral grains, but of crumbs or aggregates. These include colloidal matter of two kinds—mineral colloids and organic colloids. The latter may be partly humus, which may be regarded as an *end-product* of the microbial decomposition of organic matter. In a fertile soil the organic matter includes a sticky material less inert than humus, and resulting from the recent decomposition of organic matter[13]. This organic cement sticks the grains together into small crumbs which have the most desirable physical properties. It is not the microbes which are important in soil, but the products of their recent activity are important.

There is reason to believe that the plant and the soil with which it is in contact form a practical continuum. This contention gains weight from the work by H. Jenny and R. Overstreet on ionic exchange. If plants are grown in mixtures of sand and calcium clay, the roots accumulate calcium ions, whereas the clay particles gain in adsorbed hydrogen ions. Contact exchange is postulated to take place only when the (cation) oscillation spaces of particles overlap: the particles may be both clay, or one may be a root surface, both being negatively charged. Contact intake is difficult to investigate on account of a presumed high gradient of carbon dioxide in the neighbourhood of a root, but there is very suggestive evidence of contact depletion, so that the theory of contact exchange of ions may be regarded as having made a promising beginning. There is yet no evidence for contact exchange of anions. No contact jumping of cations could be found between roots and positive iron hydroxide sol[14].

The disposition of materials by plants is a highly dynamic and largely cyclic set of processes. There are, of course, wheels-within-wheels: short-period cycles as well as long-period cycles. The broad cyclicity of nutrients is well shown in the tropical rain forests, where most of the nutrient stock remains, and the greater part of the nutrient cycle takes place, *above* the ground. In cool humid climates the cycle is impeded, and valueless plants such as heather constitute the type vegetation. The ideal agricultural soil is one in which the cycle is fairly shared between soil and plant. Artificial modifications in pursuit of the full roundedness of the soil/plant cycle are the purpose of man's operations in cultivation and manuring.

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AD ASTRA*

By THE RIGHT HON. LORD BRABAZON, P.C.

I THINK I am speaking the truth when I say that those who were responsible for the birth of flight thought of it as a new force in the world for peace, for prosperity and for true internationalism. Here was to come something which would make the world a happier place by a quick form of transport, that would bring us all closer together. It was for that idea that I saw my friends pour out their meagre fortunes in experiment, and risk their splendid lives in brave endeavour. I contend that the crushed, shapeless or charred embers of so many victims were well sacrificed, if they were to bring about such ideals. But mechanical science outstrips human wisdom, until we find we have created a juggernaut that may indeed destroy us. I want it clearly realized that if to-day flight bears the brand of Cain, it is not on the pioneers that the blame should be laid, but on foolish politicians of many countries.

Holt Thomas must bear an honoured name in trying to use war aircraft for civil purposes, with resultant commercial disaster. The Government stepped in with half-hearted support to an enterprise which meant so much to a far-flung Empire, but so lacking was vision that the only thing ever indulged in was puny assistance to civil aviation and, on the military side, the provision of a few squadrons of aircraft, always at least seven years out of date.

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* Part of the Wilbur Wright Memorial Lecture for 1942 of the Royal Aeronautical Society, delivered on May 28.

The while Governments were striving after war machines it was left to keen competition in civil aviation in the United States to bring about the first real advance in civil flying. The Douglas is so well known as not to warrant description, but it did promise that at long last the civil side of flying was to go along a separate path in development, and would become divorced from military development. It was later found that as a military bomber the commercial machine was superior to all Government-produced machines.

It has been said by many, and there is much truth in it, that it would be better for us to win the War first before we think and plan for post-war situations. This is one of those half-truths that are so very dangerous, leading one really astray.

The Germans are fighting for a post-war position. We are fighting to resist the imposition upon us and others of an intolerable post-war bondage. Surely, therefore, we both have in our minds the whole time a post-war position. If that is so, there is nothing to be ashamed about or to find deplorable in supposing victory, and to allow one's mind to browse over some of the ameliorations that we should like to see introduced into our beloved country.

The early struggles of flight had not got very far when there came the War of 1914–18. Into that effort there was a tremendous concentration on aviation. For the first time all the efforts of engineers and other men of science were concentrated on the subject with, moreover, unlimited money behind it. It was a mushroom growth not entirely on healthy lines. Field of fire, manœuvrability, lack of blind spots, rate of climb were all points of first importance. Such things as pay load, initial expense, inherent stability, economy of fuel consumption, lack of danger from fire: all those really basic matters that would have come into normal development of a new form of transport were passed by and we were left at the end with certainly a very wonderful advance, but one upon which debate may still rage as to whether the quick growth really helped the science along or retarded it.

I have said that Holt Thomas, trying to use war machines for civil purposes, found that it was an impossibility, so detached from an economic machine had the aeroplane become. Many of us hoped and prayed that a very real divergence would come about between the military type and the civil type. This was not to be, however, anywhere except in the United States, where free competition developed in a country of astronomical distances, which was made for flying development.

All Governments, almost without exception, put their hands upon the aeroplane and said that the State would do this and not allow that. They always saw through a sort of fog also that they must regretfully have at their disposal a nucleus of private firms making aircraft against the necessity of another war.

Civil aviation was born too soon from the bowels of the War of 1914–18 and was mis-shapen from the start, so that it could not, until completely reorganized from a design point of view, *fly by itself*. A vicious circle ensued, therefore, wherein firms wanted to make a civil machine, but as air transport could not pay there were no buyers, and as they had to keep alive they continued making machines that were suitable for war purposes only. Slowly the industry became the tools of the air bureaucracy of their country, who dictated to them what to make. With a lip service to disarmament, actually to keep alive an industry for war, State subsidies started up and down the world nominally to keep flying services going. Take the case, just as an example, of engine development. In all other forms of transport the C.I. or Diesel engine has displaced the petrol engine, for economy in the case of ships and for the buses of London. Notice it was adopted here not entirely for reasons of safety. But in an aeroplane the safety reason was of paramount importance. The statement that I have had given to me, that fire did not matter as most people were killed before they were burnt, is a travesty of the truth, as an aeroplane is never in more danger than when it is not going very fast and is in contact with the ground. Yet did a C.I. engine emerge? No. For this reason: Governments were not interested in it, as it showed no great advantage for war and therefore the manufacturer had no market in which to sell his product if the State-run air-service was not going to encourage such a thing.

Thus history shows that the birth of flight was of clean parents; but due to the War of 1914–18 it was branded with the mark of Cain and ever since it has been tied to the apron strings of Mars. It is a sorry story, and although here and there I and others can point to some cases of honourable endeavour to get away from the position I have described, I think that most fair-minded people will agree that what I have said is the truth.

Is there to be such lack of imagination, such supineness, shown in the world again? I feel it only right that we should consider this problem while we are under stress and strife, and plan and arrange the future. Otherwise I know that it will pass to a tired and poor post-war world with little energy or imagination, only wanting to be left alone to lick its wounds.

I take it first of all as axiomatic that those nations that have fought together and suffered together, and won together, are going to remain friends and work together. What is curious, however, is that most of these nations are, above all, nations that are concerned with very long distances as the basis of communication. I suggest that the United States, the U.S.S.R. and the British Commonwealth, with the United Nations, should announce that henceforth they jointly and solely take charge of all aircraft and all flying, that the *Usque ad Cœlum* (ownership of air above any particular piece of ground) doctrine goes and that in future they give themselves the right to fly whithersoever they like, and that no one anywhere on earth shall fly without their consent. Thus there will be a watching force to see that nowhere in the world shall a nation secretly build up an air force for mischief. This combination will be the start of a Kipling's "A.B.C." It would, of course, delegate to countries their own internal organization for local flying, but always under its broad control. But the great long-distance highways will be in their charge and run by international crews. They will at first operate war machines for intercommunication until better are made by the industry existing, which cannot be dissolved overnight. In return for taking upon itself these great powers, the World Board will guarantee all States against aggression and will constitute to itself the policing of the world. Where we make a difference from the League of Nations idea is that here we will be creating, right at the beginning, a force of transcending power that no one can challenge, instead of a debating chamber that had no force at its command. I do not for one moment lay it down that at the right time our present enemies should not come into the general scheme. The idea is world co-operation and not penalization. It is high time with the resources at our command that we protected ourselves against a world war every generation. Here in our hands we have the instrument so to do.

A world-wide development of civil flying would have great repercussions on human life and materially improve the standard of living. The exploitation of this great invention to be put to the use of man rather than his destruction is long overdue. The world shrinks in size as time separation diminishes. Mails and passengers would be the first to be served, movement of heavy goods for some time remaining in the hands of the older systems of transportation. What the world holds for us in tariff barriers in the future we do not know, but it is to be hoped that an easier, freer circulation of travellers to and from all countries will be encouraged rather than at present frowned upon by a narrow spirit of nationalism. There are also great tracts of land, rich and climatically possible, waiting to provide a happy life for many, who at present due to lack of communications cannot live there with their kith and kin. With flight our servant, there should be no corner of the earth not readily accessible.

You may say this is post-war planning with a vengeance. To which I reply that there is no one fighting on any front who has not in his heart the idea of a fairer world afterwards where his children and for a time he himself can go about his lawful occasions.

We in Great Britain have seen a revolution take place peacefully in our land over the last twenty years. There is much more to be done. But no amount of planning of our lives and our social progress can be of value or be permanent unless we see clearly and appreciate the potential danger that man has created through the conquest of the air, and so organize the future that it is no longer a threat, but becomes the servant of man. To finish the job we have in hand and then to drift into a fools' paradise would be a tragedy little worthy of the efforts we have made to remain masters of our own destiny.

NEWS and VIEWS

Colonial Policy

MR. HAROLD MACMILLAN, Parliamentary Under-Secretary of State for the Colonies, gave an informative account of the activities and plans of the Colonial Office, in moving the vote for that Office in the House of Commons on June 24. Dealing with the present, Mr. Macmillan said the Allied losses in the Far East mean an immediate and important loss of supplies; 60 per cent of the tin production of the world, 90 per cent of the rubber production, a large proportion of the wolfram and lead, and valuable sources of sugar, tea, rice and oil seeds have fallen to the enemy. Making good the deficiencies will mean an immense increase in Colonial production. In an endeavour to bridge the gap which must occur before large-scale production of synthetic rubber in the United States can be effected, the rubber output of Ceylon has been intensified, the services of Malayan planters have been obtained to assist in reviving plantations in Tanganyika, and wild rubber in East and West Africa is being tapped. Mineral production in the Colonies is being stimulated. The Colonies are also contributing notably to the war effort by decreasing their imports. West Africa is concentrating on the production of rice, vegetables and dairy produce; East Africa is increasing its production of wheat, maize, rye and other foodstuffs. In the West Indies an attempt is being made to introduce more and diverse food crops.

Mr. Macmillan went on to speak of the future. The governing principle of the British Empire must be partnership, he said, and there must be room for the greatest divergence of local responsibility. We must begin now to prepare for changes in the organization of the Colonial Service, with two main objects. First, the civil services and the educational systems of the several Colonies must be so devised that the people are able to qualify for, and desire to serve in, the public services of their own countries. Help would still be needed from outside, however, and this could be provided by a mobile force of experts in administration, medicine, agriculture, finance, etc., at the disposal of the Secretary of State for posting to whatever Colony they are needed at a given time. In this way the present anomaly of the poorer Colonies not being able to obtain the services of the best brains—of which they are actually in greater need than the more advanced and wealthier Colonies—would be removed. Plans are being worked out to achieve this end.

As regards questions of labour and development, Mr. Macmillan remarked that six experienced trade unionists from Great Britain have recently been appointed as Colonial labour officers to British Guiana, Trinidad, Nigeria, the Gold Coast, Sierra Leone and Palestine, to stimulate the growth of trade unionism; and twelve officers from the Ministry of Labour have been seconded for service in local labour departments. Lord Hailey, with the help of eminent men of science, will advise on the organization of research, for which £500,000 a year will be available, on health, nutrition, education, etc., and also on practical economic needs. The Colonial Development and Welfare Act provides for long-term planning, which must be used to assist the Colonies to reach present-day standards of life in the shortest possible time.

THE membership of the Colonial Research Committee referred to by Mr. Macmillan has since been announced. It is as follows: Lord Hailey (chairman); Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research; Prof. A. V. Hill, secretary of the Royal Society; Sir Edward Mellanby, secretary of the Medical Research Council; and Prof. W. C. C. Topley, secretary of the Agricultural Research Council.

Part-time Employment

A PAPER on "Part-time Employment" read before the Royal Society of Arts on June 10 by F. C. Hooper, joint managing director of Messrs. Lewis's, Ltd., describes the inception and working of the part-time scheme of that firm. The details of the scheme were worked out in July and after submission to the Ministry of Labour the scheme was launched by advertisement on August 18. The appeal was addressed to married women of thirty-five and more to avoid the problem of married women with very young children, and particularly with a view to the rapid release of younger women. Mr. Hooper lays considerable stress on the patriotic appeal, sufficiently so to raise the question as to whether it is right to allow non-industrial industry to utilize part-time labour in this way unless it can be demonstrated that all munition and other essential industrial demands for labour have been fully met. Apart from this the paper lays down a number of principles which are clearly of value in launching any such scheme and which go far to determine success. The regular character of the job and that it is for a fixed time during the day or fixed days during the week, as well as the importance of regularity in time and attendance are impressed on all applicants, and few applicants failed to fit themselves into one or other of the schemes scheduled by Messrs. Lewis's, Ltd. Firm handling of this problem, Mr. Hooper said, has reduced bad time-keeping and absenteeism to a minimum. Much stress is also put on proper welfare arrangements and adequate training, and on the importance of utilizing all the usual means for getting the new employees over the early and most difficult stages of their employment. Accordingly, although a fairly large proportion of the first applicants were lost, fewer really unsuitable applicants are coming forward. Moreover, the firm has been surprised at the comparative ease with which part-time workers have fitted into their administration and at the quality of the part-time workers themselves, the average age of whom was about forty-five.

In addition to the stress on the importance of welfare and personnel work, for which a member of the Board has always been responsible, there is in each business a staff manager with high administrative authority and strictly commercial responsibility, with both a Welfare Department and a Staff Training Department. Mr. Hooper also stressed the extreme importance of explaining the scheme in advance to the management and full-time staff and of securing their co-operation and sympathy. As a result of this handling of the psychological difficulties and the putting out of clear instructions rather than appeals, in no section has there been any real difficulty in employing part-time workers. Two main methods were used. Where work requires verification and constant reference, a team of two or four part-timers work in association with one full-timer. In specialized office work wherever possible part-time workers take individual responsibility for their particular work, the size of self-balancing ledgers and salary books, for example, being reduced so that the workers can complete their work during the shortened hours. This usually works better than a team of two, one morning and one afternoon, being conducive to individual pride in one's work and avoiding the tendency for one half of the team blaming the other for mistakes. All the privileges of the regular staff are accorded to the part-time workers, who are expected to observe the same standard of discipline; the use of the term 'auxiliary' for the part-time staff has also promoted friendly relations and appealed to the patriotism of both.

Drying Blood Plasma and Blood Serum

THE Trustees of the late Sir Henry S. Wellcome have generously placed a sum of up to £20,000 at the disposal of the Medical Research Council for the purposes of research into methods of drying blood plasma and blood serum to provide stable products for use in the transfusion of patients suffering from hæmorrhage, shock, or other conditions requiring such treatment. By agreement between the Trustees and the Council, this gift is to be applied to the purchase, erection and operation by the Council of a plant which will make it possible to test and develop these methods on a substantial scale. The need for the improvement of such methods is of particular importance at the present time, and the products will be made freely available for the treatment of sick and wounded at home, at sea and abroad. The Medical Research Council has expressed its appreciation of this timely and public-spirited action on the part of the Wellcome Trustees.

Dr. Aleš Hrdlička

THE retirement of Dr. Aleš Hrdlička from the curatorship of the Division of Physical Anthropology in the National Museum, Washington, which he has held for almost forty years, is an event which no scientific journal can leave unnoted. Under him there has grown up in the National Museum one of the greatest—if not the greatest—collections of anthropological material in all the world; he is founder and leader of the enterprising school of physical anthropology which now flourishes in the United States. Born in Czechoslovakia in 1869, he was still a youth when his family emigrated to the United States; there he became a student of medicine and it was through the medical portal he entered upon the anthropological problems of the human body. On the anniversary of his seventieth birthday a list of his contributions to anthropology was compiled; they are now more than three hundred in number, covering every aspect of his subject, every one of them making a factual addition to a particular department of knowledge.

Dr. Hrdlička is beyond doubt the most travelled anthropologist of his time; there is no part of the world he has not visited in search of material and of knowledge. He made the circuit of the world several times to examine and report on the fossil remains of early man. His reports, issued from time to time in the publications of the Smithsonian Institution, are recognized throughout the world as the most reliable sources of fact relating to the discoveries of fossil man. His studies on the Old Americans (men and women of British ancestry), of the American Indians and of the Negro population of the United States have become classics. He has sought to trace the first peopling of the New World from a Mongolian homeland in north-east Asia and has explored Alaska for evidence of early migrations. In Alaska, too, he has dug up cemeteries attached to older Eskimo settlements; he has added greatly to our knowledge of the Eskimo, both ancient and modern. Dr. Hrdlička made warm friends wherever he went, particularly in England. He lectured in London in 1939 while on his way to the U.S.S.R. to examine the various finds of fossil man which have been made there in recent years. In 1926 his Czech colleagues issued a "Hrdlička" number of *Anthropologio* in honour of their distinguished countryman. At the close of the War of 1914–18 he founded the *American Journal of Physical Anthropology*, now the leading publication of its kind.

New Zealand Earthquakes

A STRONG earthquake shook a considerable area in New Zealand at about 11.18 p.m. (local time) on June 24. The places most affected were Masterton, Eketahuna, Greytown and Carterton. Property in Wellington and Palmerston North was damaged. At the southern end of the North Island, therefore, extensive minor damage was done over a wide area, windows being broken, chimneys dislodged and so forth, though no casualties have been reported. Buildings erected since 1933 under the earthquake by-laws (similar to those in force in many parts of California), have suffered only superficial damage. The main shock was preceded by a precursor shock at 8.15 p.m. (local time). The principal shock is said to have been the most severe since February 1931, when more than two hundred people were killed in the Hawke's Bay region as the result of a very severe earthquake. New Zealand is a seismic region, and hundreds of minor shocks occur every year. The study of these, and the multitude of seismological problems which arise, is actively pursued at Wellington, and we await further news of the present shock from the Dominion Observatory.

During March 1942, nine distant earthquakes were registered by the seismographs at Wellington, Auckland, Christchurch and Arapuni in New Zealand, according to the seismological bulletin just received from the Dominion Observatory, Wellington. The greatest appears to have been on March 5, when the ground movement at Wellington was 3 mm. downwards, and the shock is estimated to have had its epicentre some 82° from Wellington with a focus rather deeper than normal. The shock was recorded at Wellington at 20h. 00m. 51s. U.T. Microseisms interfered with the registration and the interpretation of the records throughout the month.

Additionally, 21 local earthquakes were recorded. The greatest was of intensity 6 on the Rossi-Forel scale (ringing of bells, stopping of clocks, visible disturbance of trees and shrubs, etc.), which occurred on March 25 at 15h. 49·6m. U.T. and was felt at Milford Sound and Queenstown. Six subsequent shocks were felt in the same area though they were of lesser intensity. Other areas affected by earthquake activity were Opotiki (March 2), Motu (March 3 and 5), Pipiriki and Whangamomona (March 5, 6, 10, 12, 16 and 18), Napier and Hastings (March 20), and Te Whaiti and Taupo (March 22). Focal depths of these local earthquakes have been estimated to range from normal (about 16 km.) to 100 km. The bulletin is stated to be provisional, but it contains much useful data.

Colour of Machines and Workshop Efficiency

UNDER the title "Color for Efficiency", Matt Denning and Arthur A. Brainerd have described experiments made in an American machine shop by re-painting the machines in pale colours (*Product Engineering*, Jan., 1942). Machines are usually painted black or battleship grey, and their surfaces thus have a low reflexion factor. There is often too little brightness of colour contrast between the work and parts of machines forming its background. If these parts are finished with light-coloured paint, contrast is improved, and the work made easier to see. Moreover, the illumination of the work itself may be improved by light reflected from machine surfaces. The whole machine may be painted a uniform colour, or a different, but also pale, colour can be used for parts not in close proximity to the work. The general brightness of a machine shop is enhanced by this treatment. Where high machines, such as heavy presses, are used, a high reflectivity of their superstructure means that more light is reflected to adjacent machines, and troublesome shadows may be avoided. The colours tested were ranked on the results of a work-time study and on opinions of machine operators and measurements of reflexion factors. Light buff proved best, then aluminium and light grey. Yellow was found to be tiring. In Great Britain, the advantages of painting machines a light colour were recognized by the Departmental Committee on Factory Lighting, which recommended this practice in its fifth report, published in 1940; recent trials here have proved very satisfactory.

Hormone Sprays for Fruit

THE recent rapid developments in the investigation of growth-promoting substances have been closely followed by widespread attempts to apply the so-called plant hormones in horticultural practice. The use of synthetic growth substances to facilitate the rooting of cuttings became a craze almost overnight, and there is no doubt that remarkable results were achieved in many cases. There are still, however, species which resist all attempts to make them produce roots readily enough to make this method of propagation practicable on a commercial scale.

Other uses for growth substances have now become the centre of interest, and these form the subject of a review in the *American Fruit Grower* of June 1941. Perhaps the most successful application has been the use of naphthalene acetic acid and naphthalene acetamide to control the pre-harvest drop of apples. Spraying with dilute solutions of these substances, by delaying the formation of the abscission layer, enables fruits to be kept on the tree until a desirable degree of colour and maturity is reached. Fruit dropping from pears, plums, apricots, oranges and cherries has also been reduced, and, in the case of the latter, the sprayed fruits showed a lower acid and higher sugar content than the controls. Satisfactory results with some English varieties of apple have been obtained by similar methods at the East Malling and Long Ashton Research Stations. The method appears to be of particular value in combating the effects of strong winds. Also of interest is the checking of bud development by hormone sprays. By this means the risk of frost injury to fruit blossoms in spring may be reduced. Indole butyric acid, applied unilaterally to growing shoots of young apple trees, causes more rapid growth on the treated side. By this means the development of narrow-angled and therefore structurally weak crotches can be avoided.

Porcelain Insulators

WRITING in the *Electrical Review* of June 12, 1942, on the design of electrical insulators in relation to manufacturing processes, Dr. E. Rosenthal points out that methods of shaping ceramic materials are based on the plastic quality of the china clay and ball clay in the case of porcelain, and of clay, talcum or bentonite in the case of certain ceramics. The plasticity of ceramic materials is caused by the adsorption of water at the surface of the kaolinite crystals forming the china and ball clays, this water surrounding the clay molecule. The forces which attract the water to the molecules and crystals are electrical in origin and impart to the clay molecules their colloidal and plastic nature. The hygroscopic water and the "water of formation" form the colloidal gels which give to the clay particles their plastic characteristics. All ceramic plastic materials also contain chemically combined water of crystallization. Although ceramic articles can easily be shaped as a result of the plasticity of their raw materials, the finished materials owe their physical and mechanical properties to the crystals and to the glass matrix formed during firing at high temperatures.

In contradistinction to ceramic plastic raw materials, the plasticity of organic plastics is not caused by water but by the long chains of carbon atoms or arrangements of carbon atoms with other elements of which their molecules consist. These chains are arranged in various forms, such as long bundles or micelles and in tangled masses composed of threads. During manufacture plastic organic materials are transformed by heat (or by heat and pressure) into a non-plastic state, nothing being evaporated. Only the structure of the big molecules is altered and as only very small shrinkage occurs greater accuracy in certain shapes can be obtained from organic-plastic than from ceramic materials. Incidentally, the molecules of ceramic plastics are built up of silicon compounds, whereas those of the organic plastics are built up of carbon compounds—an instance of the many similarities of these two elements. With organic plastics, transformation from the plastic to the non-plastic form which gives the materials their mechanical and electrical characteristics takes place at about 180° C. In the case of ceramics the formation of the crystals and the glass matrix, which imparts these characteristics, takes place between 1,300° and 1,400° C.

The difference between the manufacture of ceramic and other materials, such as metal parts and organic plastic materials, is therefore that the article is not shaped from ready-made material but has first to be prepared from various plastic and non-plastic substances. After the water is removed in a filter press the body is homogenized, and out of this body the article is shaped into the desired form which is then dried and glazed and subjected to very high temperatures for final formation. The methods of manufacturing porcelain and low-loss ceramic articles containing talcum are very similar. The article proceeds to a description of the various processes employed in the commercial production of porcelain insulators.

Stellar Structure

A PAPER on stellar structure appears in the *Observatory* of May, in which Dr. T. G. Cowling gives a brief summary of the work of various physicists on the theory of stellar structure during the past ten years. A large portion of the paper is devoted to recent developments in the physical theory of the generation of stellar energy. The work of Gamow, Weiszäcker and Bethe has shown that the most probable mode of generation of energy is by the transmutation of hydrogen into helium, atoms of carbon and nitrogen acting as catalysts in the reaction. Assuming that the temperature at the centre of a star is about 20,000,000° K., increasing temperature implies increasing rate of generation of energy—approximately as the seventeenth power of the temperature—and the popular idea was that instability of the star would ensue. This view is erroneous because the generation of energy does not affect the internal temperature for a period of the order of a million years, and in this time the star can adjust itself so as to dispose of the extra energy.

It has been argued that reaction between energy generation and temperature would produce radial oscillations, such as are observed in the Cepheids, but how can their absence in other stars be explained ? A possible explanation may be found in the time-lag between increase in temperature and the resulting increase in generation. Another explanation given by Cowling is that a very large dissipation of the energy of an oscillation takes place in the outer layers of a star, but this dissipation is so large that it is difficult to understand why Cepheids continue to oscillate. Eddington believes that the dissipation in their outer layers is very low because of the changes in hydrogen ionization during the oscillation. On the whole, therefore, there are no objections on astrophysical grounds to the view that the energy of a star is nearly all generated in the hottest central part. Other matters considered include the Kelvin-Helmholtz hypothesis that stars radiate because gravitational energy is liberated as they contract, and observational evidence regarding the internal state of eclipsing binaries.

The University of London

THE title of professor emeritus of anatomy in the University has been conferred on Prof. J. E. S. Frazer, who resigned from the University professorship of anatomy at St. Mary's Hospital Medical School in March 1940. The title of reader in geography in the University has been conferred on Dr. S. W. Wooldridge, in respect of the post held by him at King's College.

The degree of D.Sc. has been conferred on Prof. R. V. Christie, University professor at St. Bartholomew's Hospital Medical College ; Mr. Frank Dickens, of the Imperial College of Science and Technology ; Mr. Charles Potter, of the Imperial College of Science and Technology ; Mr. E. E. L. Dixon, an external student ; and Mr. C. E. Lucas, an external student.

The University of the Philippines

FEARS were expressed, in the early days of the invasion by the Japanese of the Philippines when the open city of Manila was bombed, that the University and other colleges of the city, some of them of great antiquity, might have been damaged or destroyed. It is therefore welcome news to learn that no damage of any kind has been suffered by the buildings of the University of the Philippines or, apparently, by other educational institutions. The bombing was concentrated on a small area in another part of the city.

Announcements

Archbishop Lord Lang of Lambeth and Sir Charles Sherrington have been elected trustees of the British Museum.

Sir Henry Dale, president of the Royal Society, has been appointed chairman of the Science Committee of the British Council, in succession to the late Sir William Bragg.

Dr. F. W. Hardman and Mr. W. P. D. Stebbing, in two articles in *Archæologia Cantiana* (53 and 54), have outlined the history of Stonar and the Wantsum channel. As the prosperity of the place depended entirely on the state of the channel, this is discussed at some length in the first article. While the matter is primarily of interest to the local antiquary, there are aspects which make it of wider importance.

ERRATUM. NATURE, May 23, p. 584, col. 2, line 3 of second complete paragraph : before words "striking force" insert "the effect of".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Metabolic Water and Desiccation

THE utilization by the body of ingested food substances and of tissue reserves yields among other things quantities of metabolic water. As the complete combustion of 100 gm. of fat produces about 110 gm. of metabolic water, whereas 100 gm. of carbohydrate yields only 55 gm. of water, fat reserves and fatty foods are believed to be particularly valuable as a protection against desiccation. This contention would appear to be supported by the fact that many animals which exist in deserts have large reserves of fat.

I believe that the idea that fat is primarily a protection against desiccation is based on fallacies. Terrestrial animals, which have evolved eventually from aquatic forms of life, are always apt to suffer from desiccation, and many well-known mechanisms for water conservation exist. Respiration always presents a difficulty, and a serious loss of water often takes place from the surface of respiratory organs. The more a terrestrial animal takes in oxygen, during respiration, for its metabolism, the more water there will be lost in the (practically saturated) expired air; this is equally true of insects and mammals. In man, the water lost from the lungs is generally greater than the total production of metabolic water. When desiccation is the limiting factor (and animals usually die from lack of water long before their food reserves are exhausted) the significant figure is not the amount of metabolic water produced for unit consumption of any reserve, but the amount of metabolic water produced for unit oxygen uptake. When burning fat, to produce 100 gm. of metabolic water, 255 gm. of oxygen must be absorbed; to produce 100 gm. of metabolic water from carbohydrate only 213 gm. of oxygen need be used. I believe therefore that an animal living on fat may actually be worse off as regards the production of metabolic water than one living on carbohydrate.

The same conclusion may be arrived at in a different way. Fat has a much higher calorific value than carbohydrate, but while for every 1,000 calories produced by burning fat only 120 gm. of water are produced as a by-product, when carbohydrate is burnt 130 gm. of water are manufactured for the same calorific yield. Thus if an animal performs the same sort of activities on a predominantly fatty diet, it will actually produce less water than on a predominantly carbohydrate diet.

There is one way in which the conclusion given above may need to be modified. Possibly when an animal is metabolizing fat it may obtain the extra oxygen, not entirely by increased ventilation, but partly by an increased utilization of the oxygen in the blood, with a consequent reduction of the venous blood to a level lower than that found when carbohydrate is burned. We do not know that this actually happens, for there appears to be little information concerning the composition of venous blood when different food substances are used. If it does, however, carbon dioxide production in relation to the control of ventilation must be considered. 244 gm. of carbon dioxide are produced for each 100 gm. of metabolic water manufactured from fat, and 293 gm. of carbon dioxide for 100 gm. of water from carbohydrate, so ventilation (largely controlled by carbon dioxide) and therefore evaporation from the lungs may actually sometimes be greater when carbohydrate is being used. This does not invalidate the conclusions given above concerning the amounts of water produced for each calorie when different foodstuffs are burned, and without further work it is very doubtful whether such differences in the oxygen content of the venous blood of normal resting individuals are to be found. In general then, it is clear that fat cannot in a given time give appreciably more metabolic water than carbohydrate, and most of the evidence suggests that it gives considerably less.

The only advantage of fat over carbohydrate under conditions where desiccation is likely (in deserts or lifeboats at sea) is that a smaller weight will have a higher calorific value and will give more water of metabolism than the same weight of carbohydrate. However, carbohydrate foods are generally less bulky, more easily stored and non-perishable; furthermore, very fatty diets are likely to give nausea and acidosis.

Desert animals store fat in their bodies because fat is the only food substance which animals can store in any quantities. But they store the fat as a food and not as a water reserve, for in deserts starvation is as great a danger as desiccation. In fact, many animals avoid desiccation by living in burrows where an almost saturated micro-climate is found even although the outside air may be extremely dry.

KENNETH MELLANBY.
Sorby Research Institute,
Sheffield.
June 13.

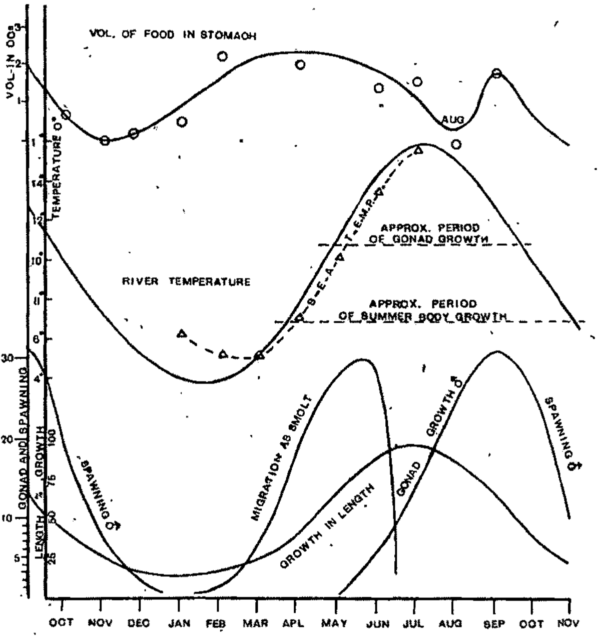
R280

Biology of Young Salmon (*S. salar*, Linn.)

IN the period immediately preceding the outbreak of the present War a close study had been made of the biology of young salmon, that is, salmon parr (*S. salar*), in various localities of Great Britain and Ireland[1-3]. It seems advisable in the existing conditions of war to review these investigations and particularly those carried out on the Welsh Dee. The accompanying figure correlates in one picture much of the work done on this river; the results obtained in other localities are not very different.

It would appear from all these investigations that rapid growth is related to feeding only at or above a particular temperature-level and may, moreover, be checked in the male by the later stages of gonad growth and spawning. Gonad development in the male is correlated with an accumulation of fat reserves following rich feeding and apparently also with a particular temperature-level. Spawning in the male is correlated with a rapid fall in temperature and a falling off in the amount of food taken (and available). Fat reserves are used up in the young male in the production of gonad but not in the female. An increase in the amount of food taken is not followed *at once* by an accumulation of mesenterial fat reserves, nor apparently an improvement in 'condition', ($K = W/L^3$), but the laying down of mesenterial fat is soon followed by testis development in the males. Smolt migration begins during the early phase of acceleration of growth in body-length, and appears to receive an early impulse about the time of the rise in river temperature from the minimum. A close relation exists between river and sea temperature at the time of migration. There is no information available yet on metabolic state at the time of migration, but mean size is known to vary with the type of environment.

How far the correlations brought out in these investigations apply to all habitats of young salmon remains to be found. The results from the Rivers Dee (Wales), Eden and the Eire rivers do not appear to be strikingly different, nor are the environments very dissimilar from a broad view, and it is recognized that strongly contrasting environments are needed to evaluate the correlations noted above. Investigations similar to and indeed more extensive than those carried out on the Dee are required from markedly different environments. Ideally, the environments chosen should cover the geographical range of the species, so that the extreme habitats in Great Britain, for example, northern Scotland and southern England, may not be sufficiently critical. The inclusion of habitats in Scandinavia and France in the investigations would greatly enhance the value of a survey on the biology of young salmon.



SOME FACTORS IN THE BIOLOGY OF SALMON PARR.

Vol. of food (Carpenter[6]) is given in c.c.'s as a criterion of food value; nutritive value estimations would be better; *River temperature* is given for the Dee (Wales) as monthly means over a period of ten years (Jones and Orton[3]); *Sea temperature* for the Liverpool Bar L.V. (1928–32) given by the broken line approximates to (and is normally lower than) that of the Dee Estuary during the migration period (Orton[8]); *Gonad growth* in the male is derived from the numerical stage of gonad × percentage of those stages in the total sample examined (Jones and Orton[3]); *Spawning* is represented simply as the decline of the graph for gonad growth in the male population; *Growth in length* is an arbitrary curve from Jones's unpublished work; *Migration as smolt*, including appearance of smolt coat, is an arbitrary curve mainly from summarized observations of J. G. D. Watts and G. M. King, during a period of 13 years, in Annual Reports, Dee Fishery Board, 1929–41; *Condition and mesenterial food reserve* follows closely the graph for gonad growth in the male (Orton and Jones unpublished, Allen[2b], Frost and Went[5]).

When data relating to a wide range of habitats are available it may not be difficult to deduce the common metabolic states and physical conditions (if any) that (1) precede and accompany and govern size at migration, govern (2) growth, (3) fat deposition, (4) gonad development and (5) spawning of the males.

The problems in the biology of young salmon therefore demand team work not only in each of several localities but also on a broad geographical basis Simultaneous team work in localities in Great Britain was being attempted at the outbreak of war; it may well be desirable in the solution of the problems to extend the team work to other countries for the purpose of comparing an adequate range of environments when investigations of this kind can be resumed.

J. H. ORTON.

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University of Liverpool.
June 4.

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[1] Orton, Jones and King, *Proc. Roy. Soc.*, B, **838**, 103 (1938).

[2] Allen, *J. Anim. Ecol.*, **9**, 1, 1 (1940) (*a*); **10**, 1, 47 (1941) (*b*); **10**, 2, 273 (1941) (*c*).

[3] Jones and Orton, *Proc. Roy. Soc.*, B, **853**, 485 (1940).

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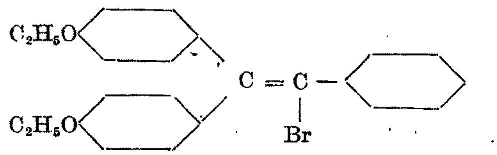
A New Synthetic Œstrogen with Prolonged Action when Given Orally

THE discovery of the synthetic œstrogens put at our disposal substances which had the great advantage of being highly active when given by mouth. Of these, stilbœstrol has been extensively used and has proved of great value. This substance, however, has only a short period of action so that clinically it has to be given at frequent intervals in order to produce a sustained effect.

We have examined a large number of substances, including derivatives of triphenyl ethylene, in an attempt to obtain an œstrogen which would produce a prolonged effect not only when given by injection, but also when administered orally, and have obtained one substance, αα-di-(*p*-ethoxyphenyl) β-phenyl bromoethylene (D.B.E.), which appears to be promising from that point of view. The formula of D.B.E. is as follows:



The activity of the substances was determined on groups of ovariectomized mice by quantitative methods previously described [1,2].

TABLE 1. COMPARING THE DURATION OF ACTION OF VARIOUS ŒSTROGENS ADMINISTERED SUBCUTANEOUSLY IN OVARIECTOMIZED MICE

Substance	Dose (μ gm.)	Duration until action halved (days)
Stilbœstrol	0·1	3
	50	9
	500	16
Œstradiol dipropionate	100	21
	500	50
Triphenyl chloroethylene	50	0
	100	12
D.B.E.	20	4
	100	93

The œstrogenic actions of D.B.E. and of a number of other œstrogens are compared in Table 1. These effects were obtained when these substances, in solution in oil, were injected subcutaneously into groups of mice in four doses over forty-eight hours.

TABLE 2. COMPARING THE DURATION OF ACTION OF VARIOUS ŒSTROGENS ADMINISTERED ORALLY IN OVARIECTOMIZED MICE

Substance	Dose (μ gm.)	Duration until action halved (days)
Œstradiol	5	3
	50	7
	500	17
Stilbœstrol	0·1	3
	500	20
Triphenyl chloroethylene	100	4
	500	13
D.B.E.	10	7
	50	21
	500	38

It will be seen, that though D.B.E. has a relatively high threshold, a small increase in the dose produces a very marked prolongation in the duration of its action. In this respect it is similar to the di-esters of œstradiol.

For the oral administration, the substances, in solution in oil, were introduced into the stomach by means of a stomach tube; a single dose was given to each mouse. Each test was carried out on a group of ovariectomized mice. The activity of D.B.E. and of a number of other œstrogens so administered is given in Table 2.

It will be seen that D.B.E. has an oral threshold similar to that of œstradiol and much higher than that of stilbœstrol. Unlike œstradiol and stilbœstrol, however, a relatively small increase in the oral dose of D.B.E. produces an appreciable increase in the duration of its action. It would therefore seem that, after absorption from the alimentary canal, D.B.E. is stored somewhere in the body and slowly released to produce a prolonged effect.

It is intended to investigate the question of the storage of D.B.E. and its possible clinical value.

The expenses of the biological part of this investigation have been defrayed by a grant from the Medical Research Council.

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[1] Robson, J. M., *Quart. J. Exp. Physiol.*, 28, 195 (1938).

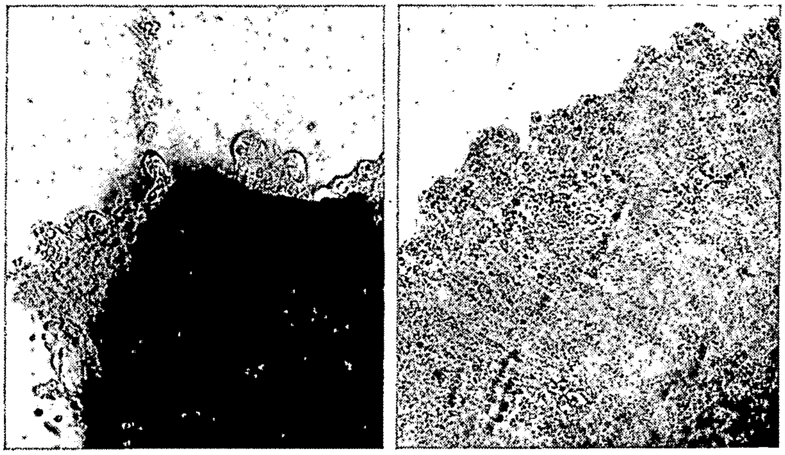
[2] Robson, J. M., Schönberg, A., and Fahim, H. A., NATURE, 142, 292 (1938).

Effect of Extracts of Heterologous Adult Tissue on Cell Growth *in vitro* and their Use in Wound Healing

IN previous papers[1] we have reported that the ability to promote the growth of cell cultures *in vitro* is common to extracts of various tissues and organs of adult animals, and that this property is independent of the rate of proliferation of the tissue from which the extract is made. Extracts of some mitotically stable organs of adult fowl (brain, cardiac muscle, smooth muscles) activate the growth-rate of chicken fibroblasts to a remarkably high degree.

Further investigations were carried out to determine whether the growth-promoting ability of adult tissue extract is restricted to homologous cells only or manifested also on cells from foreign species. Carrel[2], who was aware of the growth-promoting power of homologous adult tissue extracts, stated that whereas embryo extracts, homologous and heterologous, are equally effective, extracts of heterologous adult tissue stimulate cell-growth only slightly if at all.

The growth-promoting activity of tissue extracts was tested in the present experiments on stock cultures of chick heart fibroblast according to the technique previously described[1]. The extracts tested were prepared from heart muscle of sheep, cow, rabbit and dog. The growth of the cultures in media containing these extracts was compared with the growth of control cultures in a medium containing chicken heart muscle extract. Consistently uniform results were obtained. Heart muscle extracts of all species used have the power of strongly stimulating the growth of chicken cells *in vitro*. The pattern of the cultures and the appearance of the individual fibroblasts vary somewhat with different extracts, but the growth-stimulating effect of heterologous tissue extracts was in every case of the same order of magnitude as that of homologous extract.



a *b*

FIVE-DAY-OLD CULTURES OF HUMAN SKIN EPITHELIUM. LIVING (× 40)
(*a*) in protective medium; (*b*) activated with extract of heart of adult fowl.

These experiments were further extended to include human tissue. The question was examined whether and to what extent the growth of human epithelium *in vitro* is stimulated by extracts of heart muscle from adult fowl. Skin fragments fresh from operation (fragments of skin were obtained through the kindness of Major M. C. Oldfield) were explanted in Carrel flasks and maintained both in protective medium and in medium containing 15 per cent chick heart extract respectively. Skin fragments maintained in the protective medium (fowl plasma and Tyrode solution) showed only a few epithelium buds and shoots after five days of incubation. Fragments grown in medium containing heart extract, on the other hand, were after five days surrounded by a broad zone of densely packed epithelial cells. The growth area of newly formed epithelium in human skin cultures activated by adult tissue extract bore a ratio of 16 : 1 to that of non-activated cultures (average of fourteen experiments). The growth-accelerating effect of extract of adult fowl heart on human epithelium is thus very pronounced.

In view of the experiments reported above, the following consideration seems justified. Attempts have been made by various workers[3] to assist the process of wound healing by means of cell growth-promoting tissue extracts. The results of these experiments have been consistently favourable. The process of wound healing is accelerated, and non-healing wounds can be induced to heal under the influence of extracts which activate cell growth. Despite the favourable results of the clinical experiments, the use of growth-promoting tissue extracts in wound treatment did not find general application. In all clinical trials carried out, the source of growth-promoting substances was embryo extract, which is not particularly easy to obtain and quickly loses its growth-promoting power. This circumstance rendered this method completely impracticable. The fact that extracts of heterologous adult tissue are capable of strongly stimulating the proliferation of human cells suggests a new and simple solution of the problem. Extracts of adult tissues combine a twofold advantage : they are highly potent and they are easily available.

To sum up. Extracts of heterologous adult tissues stimulate cell growth *in vitro* to a high degree. Their efficacy in wound healing is to be expected, but has to be proved by therapeutic experiments. Treatment of wounds by adult tissue extracts is being carried out in the Surgical Department of the Hadassah-University Hospital, Jerusalem. A paper reporting the results of clinical trials is to be published shortly.

This work has been aided by a grant from the Dazian Foundation for Medical Research.

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E. Tenenbaum.

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[1] Nature, **143**, 764 (1939). *Growth*, **3**, 61 (1939) ; **4**, 207 (1940). See also Trowell, O. A., and Willmer, E. N., *J. Exp. Biol.*, **16**, 60 (1939).

[2] *J. Exp. Med.*, **17**, 14 (1913) ; **38**, 499 (1923).

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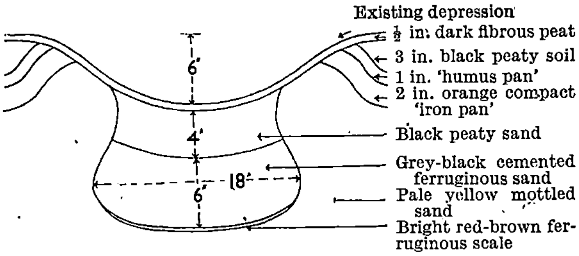
Human Activities and Soil Characteristics

There are probably few lowland areas in Great Britain where the development and characteristics of soils have not been materially altered by the impact of human activities ; it is, nevertheless, often assumed that portions of the New Forest have been little influenced by man's interference. Investigation would suggest, however, that such is far from being the case, and that comparatively unobtrusive factors have exerted effects which often obscure and complicate the fundamental soil-forming processes.

Recently, as part of an effort to improve the quality of the forest grazings, a fairly level 'moor' at Pilley near Lymington was ploughed ; the existing flora consisted mainly of *Erica tetralix* and *Calluna vulgaris* (dom.), with *Molinia cœrulea, Agrostis setacea, Ulex minor*, Carex and Lichen, in an open community. Over a considerable area, the occurrence was observed of parallel orange-coloured bands, extending in varying directions on the bottoms of the furrows, at about 4 in. below the surface. In a few instances these bands could be identified with the impressions of old cart tracks ; a typical soil profile is shown in the diagram.



According to local informants, marl was at one time carried across the moor from pits to farms lying beyond its margins. The marl carting apparently commenced about 1840, using, in the early days, oxen teams with broad-wheeled carts ; the practice was finally discontinued around 1890.

It would appear possible that the pressure of the wheels broke the continuity of the iron pan, which was forced downwards, below the rut, while the adjacent pan outside the rut was forced up and exposed at the surface. The depression was afterwards filled by washing in from the sides, and in many cases has practically disappeared. The exposed ferruginous material underwent a change in colour from orange to dull brown, and the whole became covered by a thin horizon of humous material, of recent origin.

Taken as a whole, the soil characteristics of this moor are now rather variable. Apart from the profile already described, at certain sites a typical podsolic bleached A^2 horizon is discernible ; at others, a few yards distant, the iron pan is overlain by a black peaty sand. The 2-in.-thick iron pan appears nowhere to lie more than 6–8 in. below the surface, while the superficial A° horizon of peat is only about ½ in. and the bleached sandy A^2 about 2 in. in depth.

It is difficult to believe that the present poorly developed eluvial horizons correspond with the strongly developed illuvial horizons now observable, and it is suggested that the original A° and A' horizons may have been removed by the intermittent operations of peat cutting and heath burning, known to have been practised in the past.

In the opinion of the writer, the foregoing serves to illustrate the difficulty in interpreting the various factors which have affected soil-forming processes, even in an area which, at first sight, might be thought to have developed under the influence of purely natural agencies.

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May 27.

A New Synthesis of X-Ray Data for Crystal Analysis

IT is unfortunate that Dr. Yü is not more easily accessible to direct correspondence about his new synthesis of X-ray data for the determination of crystal structures[1]. If the method is what he claims it to be, it is certainly an important advance; the details he gives, however, are not self-explanatory, and physical reasoning would suggest that the advantages he claims cannot possibly be obtained from the X-ray data given by any actual crystal.

The number of X-ray spectra obtainable from a crystal is limited by the natural decrease in intensity with angle; thus there is a limit to the resolving power of the 'X-ray microscope'. This limit is not, as for optical instruments, an artificial one that depends on the conditions of experiment; it is an expression of the fact that atoms have a natural diffuseness due to their finite size and thermal motion. Crystals composed of dimensionless atoms would give spectra that did not, on the average, decrease with angle.

Now Yü has claimed, in effect, that he has produced a synthesis with no limit to the resolving power. To do this he produces a set of quantities E_h which are related to the observed intensities but which are so corrected that they do not, on the average, decrease with angle. This, in agreement with my statement above, is the condition necessary for infinite resolving power. These E_h's are then multiplied by the quantities $a_{\mu h}$; Yü does not define these but states that they decrease with h so that his series $\sum\limits_{h=0}^{\infty} a_{\mu h} E_h$ can be terminated at a reasonable value of h. It seems to me, however, that if the high-order intensities are not included in the series, the resolving power cannot be infinite; that the convergence is in the a's and not in the E's is immaterial.

The method, of course, cannot be completely understood until all the details are available. Nevertheless, I suspect that there is no essential difference between Yü's synthesis and Patterson's, except that Yü considers his as a function that has appreciable values only at discrete points, whereas Patterson's is continuous. It is doubtful whether this concept has any advantages over the older one, but it will be interesting to see whether the publication of Yü's $a_{\mu h}$'s will lead to any simplification of the processes involved in the summations.

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Cambridge. June 17.

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[1] Yü, NATURE, 149, 638 (1942).

A Relativity Query

As is well known, Einstein's theory of gravitation predicts three small effects not previously known. Two of these are the deflexion of light rays passing near the sun and the advance of Mercury's perihelion. I have found that these are given very simply by Fermat's principle and the principle of least action respectively.

The matter can be put shortly, as follows:

$$\delta \int \sqrt{1 + \left(r\frac{d\theta}{dr}\right)^2}\, dr = 0, \qquad (1)$$

an application of Fermat's principle, gives the straight line; r and θ are two-dimensional polar co-ordinates.

$$\delta \int \sqrt{\frac{2\,km}{r} - C}\,\sqrt{1 + \left(r\frac{d\theta}{dr}\right)^2}\, dr = 0, \qquad (2)$$

an application of least action, gives the ellipse. Now repeat the two equations but suppose that the medium is very slightly ælotropic, writing

$$\sqrt{n_r^2 + \left(n_\theta\, r\frac{d\theta}{dr}\right)^2}\, dr$$

for the element of optical length where

$$n_r = n_\theta^2 = \left(1 - \frac{2km}{rc^2}\right)^{-1}$$

and c is the velocity of light. The application of Fermat's principle then becomes

$$\delta \int \sqrt{n_r^2 + \left(n_\theta\, r\frac{d\theta}{dr}\right)^2}\, dr = 0; \qquad (3)$$

and the application of least action

$$\delta \int \sqrt{\frac{2km}{r} - C}\,\sqrt{n_r^2 + \left(n_\theta\, r\frac{d\theta}{dr}\right)^2}\, dr = 0 \qquad (4)$$

The two equations give respectively *exactly* the same paths as Einstein obtains for the passage of the light ray and the planet in the sun's gravitational field. The results come out very easily. It is the slight ælotropy of the medium that constitutes the difference between Newton and Einstein. The first three equations can be obtained from the final one by omitting the appropriate terms.

Now these seem to be important results, and there is a strong probability that they have appeared in print before; but I have not been able myself to find a reference to this having happened, neither have authorities whom I have consulted. Can any reader of NATURE give me information?

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June 15.

Geologists in War-Time

MIGHT I suggest that the lack of interest shown in the work of geologists in war-time, complained of by Dr. F. Coles Phillips in NATURE of April 4 last, is a continuation of a similar lack of interest in peace-time? This subject was dealt with ably by Prof. P. G. H. Boswell in his presidential address to the Geological Society of London last year, and it is now being realized that, admirable and fundamental as pure science may be, any branch of science which is not linked to everyday life is bound to suffer the fate that is being suffered to-day by pure geology. Mining and oil geology have already robbed the science of many potential adherents, but what has struck me most since my interest in geology was aroused over twenty years ago has been its complete neglect of its possible application to allied sciences. Thus to take only those cases of which I have personal knowledge, building stones, road and building aggregates, and greater than these, soil mechanics, are all examples of subjects which could have been developed by geologists, but which have been left by them to chemists, physicists and engineers with markedly beneficial results to those branches of science and a corresponding loss to geology.

It should be realized by geologists that the natural corollary to the statement made above is that a greater interest in allied sciences by them is needed; the impetus must come from them; it will certainly not come to them from other quarters.

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May 30.

RESEARCH ITEMS

Development of the Liver in the Salmon

Helen I. Battle has investigated the hepatogenesis of the Atlantic salmon (*Salmo salar* L.) (*Canadian J. Res.*, 20, Sec. D, No. 4; April, 1942). Little is known about the early embryology of the liver in teleostean fishes, expecially of the Atlantic salmon, and this detailed study is a valuable contribution to the subject. Many problems of interest arise, not merely in the embryonic phases but also following the larval period, when the liver undergoes an enlargement, and a differential growth accompanies the metamorphosis of other structures already observed as constituting the transition from parr to smolt. The present work deals with the gross morphological changes in the liver during development from the initial appearance of the 'anlage' in the 4-mm. embryo to the adult. A later paper will deal with the simultaneous histogenesis.

American Freshwater Amphipoda

Clarence R. Shoemaker has given useful keys to the families and genera of American freshwater Amphipoda, describes several new species, and redescribes others imperfectly known ("Notes on Some American Freshwater Amphipod Crustaceans and Descriptions of a New Genus and Two New Species", *Smithsonian Misc. Coll.*, 101, No. 9. Smithsonian Institution of Washington, Publication 3675; 1942). Among the new species are some interesting cave-dwellers. One is from a cave in Cuba described first by Ada L. Weckel and now placed in the new genus Weckelia, another is a large Crangonyx from caves in Pennsylvania, discovered by Kenneth Dearolf, representing a new species, *Crangonyx dearolfi*. Four families of freshwater Amphipoda are so far known from America: Corophiidæ, Talitridæ, Haustoriipæ and Gammaridæ. Only one genus each is represented in the Corophiidæ (Corophium), Talitridæ (Hyalella), and Haustoriidæ (Pontoporeia), but there are two sections in the Gammaridæ, the Gammarus and Crangonyx sections, with several genera.

Translocations in *Appotettix eurycephalus*

R. K. Nabours, F. M. Stebbins and W. R. B. Robertson (*J. Exp. Zool.*, 38, 239; 1941) report further results from X-raying males of *Apotettix eurycephalus*. Among the translocations observed in the progeny were two translocations: between chromosomes 1 and 4 and between chromosome 1 and the *X*-chromosome. Genetical analysis of the genes *OTG* and *W* and cytological evidence enable the authors to place the genes on chromosome 1 in respect to the centromere. In the case of the reciprocal translocation involving the *X*-chromosome and chromosome 1, it was found that the autosomal gene *W* had become transferred to the *X*-chromosome and showed sex linkage. Considerable data of the viability of animals with different chromosome abnormalities were obtained and it was shown that quite frequently a zygote with an abnormal chromosome constitution lived until the third or fourth instar.

Localized Chiasmata in *Fritillaria Meleagris*

Meiosis in normal *Fritillaria Meleagris* is characterized by the bivalents being held together at metaphase by chiasmata strongly localized near the centromere. By treating the early stage of meiosis with colchicine and with heat, H. N. Barber (*J. Genetics*, 43, 359; 1942) has been able to analyse the phenomenon more fully. He finds that heat treatment at the time of chromosome pairing reduces the chiasma frequency and tends to increase the proximal localization. On the other hand, treatment with colchicine reduces the chiasma frequency, and localization disappears. Indeed with colchicine pairing takes place at several places on the chromosome, which results in considerable interlocking. The interpretation given is that heat reduces the time limit of pairing and thus reduces the chiasma frequency without influencing the general method of pairing. Colchicine, on the other hand, by influencing the region of the centromere, reduces its advantage in pairing and slows the general rate of pairing. Normal localization in *F. Meleagris*, therefore, is taken as depending on an early limit of pairing and a centromere control of the contact points of the chromosome.

Respiratory Channels in the Tomato Fruit

K. A. Glendenning, biochemist at the National Research Laboratories, Ottawa, has followed up some observations upon the respiratory activity of the detached fruit of the tomato with a study of the behaviour of the fruit while still attached to the plant (*Canadian J. Res.*, 20 (4); April, 1942). There is clear evidence that the ripening colour change on the vine involved at first a rise in respiration, to the yellow orange stage, followed by a decline as the fruits ripened to full red. A similar respiratory drift had been noted in detached fruits, and there the remarkable fact had been observed that this rise and fall may be abolished completely and the associated colour changes seriously modified, by blocking the stem scar area with melted wax. It is known that the act of detachment does not interfere seriously with respiratory activity so it was interesting to see if any region could be blocked in the still attached fruits so as to modify the respiratory ripening changes similarly. It was found that fruits failed to show the normal colour changes when melted wax was applied to the area of the fruit ordinarily covered by the calyx and also to the parts of the pedicel immediately adjacent to the receptacle and to the receptacle itself in the angle between pedicel and fruit. Most of these fruits abscissed relatively early. The area of free gaseous interchange in the attached tomato fruit thus appears to be associated with this surface region of the fruit.

Carboniferous Lycopods

J. M. Schopf's recent work on American material makes valuable progress with the fossil Lycopods. One paper (Illinois Geol. Surv., Rep. of Investigations, 50) deals with isolated megaspores, which are now coming to be used as one of the means for recognizing individual coal seams. Various types are discussed, including ones belonging to Lycopod seeds for which a genus is made. A second paper (*ibid.*, Circular 73) consists of a critical discussion of the Lycopod seeds Lepidocarpon, which are numerous in America. A third (*ibid.*, Report of Investigations, 75) deals with the rather obscure genus Mazocarpon Benson. A new species is described from abundant male and female cones which are so well preserved that the single large archegonium of the female prothallus is clearly seen. Various points are cleared up; for example, the ligule which is recognized; and it is interesting that the idea that this is the cone of Sigillaria is strongly supported, and also that the megaspores are shown to be one of the commonest types in coal seams. The idea that this cone shows an approach to the seed production of Lepidocarpon must be given up. It is specialized on different lines, but at the same time it is not yet clear how the spores were shed. This remarkable material should be able to provide information on this and other points of the life-history of Sigillaria.

Constitution of Agar

IN some experiments described by W. G. M. Jones and S. Peat (*J. Chem. Soc.*, 225 ; 1942) evidence is presented that agar is the sulphuric acid ester of a linear polygalactose, the unit chain being composed of nine *d*-galactose residues mutually combined by 1 : 3-glycosidic linkages, and terminating at the reducing end by a residue of *l*-galactose, united with the rest of the chain by a glycosidic linkage engaging C_4 and not C_3. The *l*-galactose member is esterified at C_6 with sulphuric acid. This structure is shown to account for some reactions studied. The interesting suggestion is made that in the biological synthesis of agar a sulphate fulfils a similar function to the phosphate in the enzymatic synthesis of starch from glucose 1-phosphate, and this is explained more fully. The phosphoric acid is not retained in the starch, but with the agar the sulphuric acid, functioning as *d*-galactose 1-sulphate, remains with an adjusted orientation as an integral part of the molecule.

Copper Compounds

THE hydrated blue gel thrown down by addition of a base to a cupric salt solution passes into black cupric oxide at a rate depending on the conditions of formation. H. B. Weiser, W. O. Milligan and E. L. Cook (*J. Amer. Chem. Soc.*, 64, 503 ; 1942), by phase rule and X-ray diffraction methods, have shown that $Cu(OH)_2$ is the only compound formed in the $CuO—H_2O$ system, although four definite lower hydrates have been reported by another worker. The brown to black oxide CuO is formed by spontaneous decomposition of the cupric hydroxide gel, this being (as has long been known) accelerated by contact with dilute alkali. If the ratio of equivalents of cupric sulphate to alkali in a mixture is less than or equal to 1, the blue precipitate is pure cupric hydroxide ; if it is equal to or greater than 1·33, the precipitate is basic sulphate, $4CuO, SO_3, 3H_2O$, identical with the mineral brochantite ; if the ratio is 1·25, it is a new compound, $5CuO, SO_3, xH_2O$; if between 1 and 1·25 a mixture of this and cupric hydroxide ; if between 1·25 and 1·33 a mixture of the two basic sulphates formulated above. The identity of the new basic salt $5CuO, SO_3, xH_2O$ was established by several methods, including analysis of crystals.

Renin

IT was known that the intravenous injection of saline extracts from fresh kidneys causes a prolonged rise in blood pressure, and this has been shown to be due to the presence in the extract of a protein renin, soluble in water and dilute salt solutions, insoluble in alcohol and deactivated by heat and capable of purification by fractional precipitation by ammonium sulphate. O. Schales (*J. Amer. Chem. Soc.*, 64, 561 ; 1942) has now described a method by means of which it can be obtained in good yields and with a high degree of purity. This is a long and rather complicated process, which is set out in detail. Renin appears to be a pseudoglobulin. No evidence of the presence of a removable prosthetic group has so far been found.

Structure of Complex Fluorides

INTEREST has recently been taken in the determination of the structures of complex ions containing fluorine and apparently having the unusual co-ordination number of 7. Cubic crystals of potassium and ammonium heptafluozirconates contain the ZrF_7''' ion with point-group symmetry of $C_{3y} - 3m$. The fluoxyniobate ion $NbOF_6'''$ has a similar configuration in cubic crystals of $K_3 NbOF_6$. Monoclinic crystals of the isomorphous K_2NbF_7 and K_2TaF_7 contain the complexes NbF_7'' and TaF_7'' with the point-group symmetry $C_{2y} - mm$. J. L. Hoard and M. B. Williams (*J. Amer. Chem. Soc.*, 64, 633 ; 1942) have now examined the structure of $(NH_4)_3SiF_7$ by X-ray analysis. The result shows that this does not contain an ion with 7-covalency similar to those just mentioned, but the crystals are ordered aggregates of $NH_4^{\cdot}$, F' and octahedral SiF_6'' ions, and hence the salt (which was discovered by Marignac in 1859) can best be represented by the double-salt formula $(NH_4)_2SiF_6, NH_4F$. Some of the interatomic distances are 10 per cent larger than anticipated for the co-ordination number involved. This is correlated with the very soft character and limited stability of the crystals, and the unusually large effects of thermal vibrations on the observed intensities of the diffraction maxima.

Defects in Glassware

AT a meeting of the Society of Glass Technology on June 16–17, A. J. Holland, Eric Preston and W. E. S. Turner presented a paper on "Cords, Surface Finish and the Quality of Glassware". Omitting from consideration those defects classed as stones, seeds or blisters, the two main defects which impair the quality of glassware are those which occur in the body of the glass due to the presence of 'cords', and those present on the surface and which are largely dependent on mould conditions. A comparison was made of direct-shadow, polariscopic and photo-optical methods of determining cordiness. For routine comparisons and control, the direct-shadow method is extremely sensitive and excellent degrees of cord estimation can be accomplished in this way if preliminary standards are first set up over a sufficiently wide range—a 'figure of merit' was obtained depending on the range of cordiness covered by the reference samples. A thermostatically controlled centrifuge was also set up to separate from finely powdered glass samples glass of differing densities, and in this way an estimate of cord could be obtained either by giving the total density spread of a sample, or the mass-density distribution in the form of a grading curve. The defects which occur on the surface of the ware arising from contact with moulds or tools used in shaping the glass object have been but little investigated. A general comparison of surface conditions can be made, again, by a shadow method, but an optical method is to be preferred. It is even more difficult to give a numerical value for surface condition than for cord, but again a satisfactory 'figure of merit' is obtainable from standards set up and photographed at magnifications between 50 and 100 under conditions of oblique illumination. A scheme is in hand, however, for the utilization of an optical method, which, as in the case of cords, would give a value independent of the observer's judgment. In view of the minuteness of the surface unevennesses, however, it is not anticipated that such a method would be very sensitive.

RECENT ARCHÆOLOGICAL RESEARCH IN TRANSCAUCASIA

PROF. B. A. KUFTIN has been carrying on important excavations in Transcaucasia (1936–39): he made a preliminary report to the Leningrad Institute for the History of Material Culture (*Kratkie Soobshcheniya*, 8, 1–35, figs. 1–18; 1940) and the definite statement of his results has now been produced by the Georgian Academy of Sciences.

In the latter part of the last century, Russian, and some European, museums were flooded with objects from Koban, Samthavro, Kumbulta, Faskau, Rutkha and other sites in the main chain of the Caucasus. They were very handsomely published by the Countess Uvarov and others (for example, *Mat. po Arkheologii Kavkaza*, 8), being obviously of great interest, but being the result of predatory excavations carried out upon very steeply sloping sites had no stratification recorded: things from 1500 B.C. to A.D. 500 were all jumbled up together. Prof. Kuftin excavated a series of sites farther south yielding analogous objects and throwing light on these older finds; for example, things which had been regarded as perhaps decadent and belonging to the last centuries B.C. now turn out to be primitive and can be safely put at 1500 B.C. His sites range from epipalæolithic with the obsidian tools long known in Caucasia, to Hellenistic, Roman and Sassanian times. He has also introduced some order into the different styles of painted pottery, correlating them with those in Elam, Mesopotamia and the regions north of it. He points out that the brilliance of the Van kingdom has concentrated attention on that period within its area, and that we know very little of what went before it.

Without a large number of illustrations it is impossible to convey an intelligible idea of these results. It may be said, however, that Prof. Kuftin has correlated the Cyclopean forts of southern Transcaucasia (*c.* 2000 B.C.) with painted pottery in form and decoration startlingly like Hallstatt forms of a thousand years later.

More surprising are Prof. Kuftin's results obtained on the River Tsalka (lat. 41° 60′, long. 44°), tributary of the Khram, which is being dammed to get electric power. The U.S.S.R. is very good at seeing that such inundations are not made until the area has been examined for archæological remains. First he found barrows with the Hallstatt-like pottery, black glaze over pink; then two other types with light slip, one with shiny black rectilinear ornament, birds, chevrons and swastikas, the other with a cream slip adorned with spirals, volutes and rosettes. The burials were some on the original surface of the ground, others in great pits up to 14 m. long approached by a sloping way. Besides the pots with light slip, these yielded most remarkable metal work; for example, a gold cup adorned with filigree and jewels and set on a pierced base (looking almost like Byzantine work), a silver bucket with hunting scenes in repoussé gold, silver pins with filigree and gems, a silver blade, a necklace with very big beads, an agate pendant set in gold, also grey-blue beads which should help in determining affinities. Another grave had a socketed silver spearhead, not a common thing, and so making one think of the Borodino find, as the gold cups recall Vlči Trn, which likewise seems to belong to a painted pottery culture.

Many of these things resemble those from Ur and Uruk (2500–3000 B.C.) but the technical advance in gold work would seem to point to *c.* 1500 B.C., and the figure-work has some resemblance to Hittite sculpture at Yasilikaya, still untouched by Assyrian influence. There is certainly an element independent of Sumer and not unlike predynastic Egyptian, for example, the Gebel-el-Arak knife-handle. As there are no horses and no iron, we must not bring things down too late. The funeral car found in one tomb is still of the four-wheel type. Whatever the affinities of this new culture turn out to be, it is interesting to set another stone in the arch of painted pottery extending from Baluchistan by Iran and Asia Minor to Transylvania, and if we were bold, we might hope that we have the Hurri or kindred tribes before they moved south.

ELLIS H. MINNS.

PLANKTON OF IRISH LOUGHS*

W. H. Pearsall and Edna M. Lind have made some interesting preliminary researches into the analyses of the ecological relationships of the phytoplankton in numerous small Irish loughs. Twenty-six loughs were studied, ranging from one to seven kilometres in length. These are divided into (1) calcareous loughs (with Chara species abundant), subdivided into those with mainly soil drainage, and those with much peat drainage, and (2) the less calcareous loughs, subdivided into those with oxidized peat drainage, unoxidized peat drainage, the larger stream-fed loughs, and a few left unclassified. This classification agrees well with the algal distribution.

The plankton floras of the different loughs tend to fall into consistently different categories, of which at least four can be distinguished: those of the calcareous loughs with mainly soil drainage, those of the calcareous loughs with much peat drainage, those of less calcareous loughs with oxidized peat drainage, and the large stream-fed loughs. These four represent distinct plankton communities of algæ and as such they could be used in comparison with other plankton communities. The lists as a whole can be analysed to show the habitat range of individual algæ, which should be useful as indicators of water conditions.

The species are classified into three groups: *A*, those mainly characteristic of or most abundant in peaty conditions; *B*, those apparently indifferent to the presence or absence of peaty matter; *C*, those mainly characteristic of, or most abundant in, less peaty conditions. Among the indifferent species occurring in peaty conditions the cosmopolitan dinoflagellate *Ceratium hirundinella* is conspicuous. Diatoms, on the other hand, are less prominent in the peaty loughs but are numerous in the calcareous loughs. It is shown that the bulk of the calcifuge peaty species are distinctive in that they can grow almost equally well in bogs, and the non-pelagic character of these may mean that they are dependent on the presence of an adjacent peaty substratum. The truly planktonic species more characteristic of the less peaty water may have some feature of structure, life-history or metabolism which enables them to maintain a mainly pelagic existence in the large lakes.

The authors regard it as probable that the primary factor in distribution may be the nature of the dissolved solids carried into the lake from its drainage area, a conclusion already reached by the Wests (1909) and by Pearsall (1932). In the peaty loughs where acid conditions predominate these dissolved solids include a large proportion of vegetable organic matter in a slightly oxidized condition with a small amount of decomposition products, in contrast to the less peaty loughs where the organic matter carried into the loughs is comparatively highly oxidized with a large amount of products of oxidation including nitrates. The general effect of such conditions is the greater proportion of diatoms most noticeable in the calcareous loughs.

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* The Distribution of Phytoplankton in some North-west Irish Loughs. *Proc. Roy. Irish Acad.*, 48, Sect. B, No. 1; March, 1942.

'BOG-BUTTER' FROM SKYE

THE practice of burying kegs of butter or body fat with the object of preserving or improving the flavour of the product continued in Ireland from an uncertain period of antiquity until the end of the eighteenth century. In Scotland, too, similar kegs of fat have been recovered from the peat bogs, though none of as recent date as some of the Irish finds that have come to light. The preservation of fatty substances has always been a problem of human economy which has only been partially solved in our own times with the advent of cold-storage, and the burying of kegs of fat in deep peat holes and leaving them there for any length of time up to seven years, when the flavour is said to be at its best, was probably a considerable contribution towards its solution.

The particular example now described by Prof. J. Ritchie (*Proc. Soc. Antiq. Scotland*, **75**; 1940–41) was discovered by Dr. Hugh Mackay in 1931, while peat was being cut about one mile east of the inn at Kilmaluag at the northern end of Skye. When found, the wooden keg was embedded in the solid peat bank, being tilted a little to one side. It would seem that it had been lowered into a fairly deep peat hole and for some reason forgotten or lost. The body of the barrel was hewn from a solid piece of wood, as also were the circular lid and bottom, though the diameter of the keg was some 15 inches and the tree from which it was made a birch. The workmanship was excellent, the thickness surprisingly uniform throughout. At the top of the barrel where the rim is otherwise bevelled off there are two upward projections nearly three inches high and each pierced by two holes, through one pair of which a cord could be passed for lowering the keg, while a small stick placed through the lower pair would have held the lid in place. Half-way up the body of the keg and not symmetrically placed on its circumference there are two more projections, this time lug-like, the holes having been burnt through the solid wood. It is suggested that these were useful when the keg was slung over a horse's back.

The mass of buttery fat itself has been analysed, but what it was originally could not be certainly determined. Some hairs were present, however, in the amorphous mass, which were mostly those of cattle, though a few human, dog and horse ones were also identified. On the whole, this would tend to suggest that the fat was originally a true butter.

Various methods were used in attempts to date the find—pollen analysis, associated finds, etc.—but no conclusive results could be given. Considering everything the writers are inclined to ascribe the find to the opening years of the Christian era.

M. C. BURKITT.

MELLON INSTITUTE OF INDUSTRIAL RESEARCH

THE twenty-ninth report of the Director of the Mellon Institute of Industrial Research, covering the year ended February 28, 1942, refers to the increase of the industrial research staff from 187 to 205 fellows and from 114 to 150 fellowship assistants engaged on some ninety-five industrial fellowships. Of the eight fellowships terminated during the year, that on carbon blacks as absorbents was concluded by a study of the activation of colloidal carbons with the object of determining their possibilities for use in absorption either in their original form or after treatment. Some carbon blacks prepared in pellet form with a suitable binder and activated by steam showed remarkable increases in their capacities for absorbing vapours and for purifying water.

Special interest is attached to the investigations of the Department for Research in Pure Chemistry, and studies in the chemistry and chemotherapy of modified cinchona alkaloids and related drugs have continued. In experience to date, no beneficial result of quinine cannot be obtained equally well with hydroxyethylapocupreine, a drug which is greatly superior to quinine in pneumonia, in infections of the eye and throat and in certain asthmatic conditions. In view of possible difficulty in obtaining adequate supplies, cinchona alkaloids investigations are in progress aiming at the preparation of simpler compounds which can be prepared from more easily available materials. Studies have also been carried out for the twelfth revision of the U.S. Pharmacopeia, and a number of projects have been subsidized by the Mellon Institute at the Institute of Pathology of the Western Pennsylvania Hospital, particularly on the effects of the sulphonamides on the tissues of the host and on the infecting agent in the tissues. A new sulphhydryl preparation ('Hydrosulphosol') has been found to be of value in the treatment of burns, stimulating rapid healing and discouraging infection. Other work has continued on natural resistance and the common cold, and on the role of certain enzymes in the metabolism of oxygen and carbon dioxide.

Particular reference is made to the work of the Industrial Hygiene Foundation, a combined research and service association for health protection in industry which maintains its headquarters at the Mellon Institute; this Foundation was originally known as the Air Hygiene Foundation, the change of name having been made during the past year. The investigations of the Foundation have covered the effect of arc-welding fumes on susceptibility to tuberculosis, the reactions of living tissues to silica granules, the evaluation of X-ray films for use in physical examinations in industry, and on the present exhaust ventilation systems for control of health hazards. Since early in 1941, the Foundation has been studying sickness absenteeism in industry, and fatigue is also receiving constant consideration. Work on aluminium powder as a possible preventative in silicosis is also reviewed in the report.

Of other industrial fellowships completed during the year reference is made to work on new pre-cast concrete units such as columns, girders and hollow floor and wall panels, the speed of erection of which is the basis of their utility, and an investigation on safety fuses initiated in 1930 has also been completed. With regard to fellowship researches in progress, 'Anthrafloss' is a high-grade mineral wool for insulating purposes developed from anthracite by-products by the multiple fellowship of the Anthracite Industries Incorporated. The multiple fellowship on heat insulation and proofing has assisted in the development of an efficient insulating material suitable for use for temperatures up to and including 800° C. The research programme of the multiple fellowship on plastic metals has resulted in the construction of a large commercial sponge-iron plant. Other fellowships have led to improvement in the manufacture of grey cast iron and steel, while a further fellowship has been devoted to the refining of chromium. Steady progress has been made in the utilization of waste pickle liquor under a multiple fellowship of the American Iron and Steel Institute. Five potential processes for the recovery of materials from this industrial waste have been investigated, including the recovery of free sulphuric acid and ferrous sulphate, the manufacture of iron carbonate and ammonium sulphate, the manufacture of magnesium from low-grade ores by heating with waste pickle liquor and the preparation of sodium sulphate and ferric chloride. Other fellowship researches have related to cast iron enamelling, hollow-ware enamelling materials, flat glass and waste grinding sand from plate glass manufacture. Substantial advances in methods for evaluating the flatness and texture of surfaces has been achieved under the multiple fellowship on plate glass technology.

Under the multiple industrial fellowship on sulphur investigations relating to sulphur cements, reaction of gaseous olefines with sulphur and the use of sulphur as a filtering medium are in progress. The same group has discovered a novel series of accelerators for rubber, as well as prepared further organic derivatives from ammonium thiocyanate. The upgrading of the components of coke-oven light oil, the physical properties of tars and pitches and their improvement, as well as the development of new products from tars, the commercial recovery of cyclopentadiene and the recovery of isobutane and isopentane from natural petroleum and casing-head petroleum have been investigated under other fellowships. The feasibility of installing a butane extraction plant, a product used in the manufacture of butadiene for synthetic rubber, has been demonstrated. Other work in the field of natural gas technology has related to corrosion problems. The multiple fellowship on petroleum has again been very active, its investigations including a study of the chemical constitution of high-melting waxes, research on fractional distillation under diffusion pump vacuum and on the chemistry of petroleum.

The multiple fellowship on organic syntheses established by the Carbide and Carbon Chemical Co. has extended its investigations on the manufacture and application of amines, detergents, lubricants, hydraulic fluids and synthetic resins, and a soluble lubricant for processing woollen fibres has been developed. The fellowship on chemical hygiene has continued its investigations on the physiological effects of new chemical compounds, including the 'Tergetol' penetrants and the acute oral toxicity of glycol derivatives. The multiple fellowship on food varieties has perfected a new type of instant baby cereal, and initiated a project which will survey the whole field of fruit flavours; problems of the rapid tenderization of meat have also been investigated.

Cotton investigations have included studies on the fibre, the practicability and methods of adapting virgin cotton to the manufacture of high-grade papers, and fundamental research on the properties and structure of cotton cellulose and the influence of such processes as mercerization. Encouraging progress has been made in research on cotton-seed, and the industrial fellowship on felt has devised methods for imparting to paper, machine felts and other woollen industrial fabrics markedly improved physical characteristics and resistance to chemical injury, and has also devised a process for rendering wool and woollen fabrics non-shrinking and non-felting. An improved system of wool scouring and scouring control has given an average daily increase in production of more than 75 per cent. A third textile fellowship has led to important advances in processing hosiery yarn, particularly 'Nylon'. Yields and grades of glue have been improved by a fellowship on bone products which has also investigated granular absorbents for use in sugar refining. The fundamental problems of rubber technology are being studied by another fellowship, and 'Raolin', a special chlorinated rubber, developed by a Mellon fellowship research, is being allocated according to Federal Government instructions. Research on polymerizable silicon compounds is being carried on under a further fellowship and certain applications have been proposed which are of potential utility in warfare. Other research is related to the use of plastics in water- and gas-meters and for many other purposes.

HEAT ENERGY FROM RADIOACTIVE SOURCES IN THE EARTH

THE supremely important subject of the amount of heat derived from radioactivity within the earth is the subject of a recent paper by William D. Urry, of the Geophysical Laboratory, Washington ("Heat Energy from Radioactive Sources in the Earth", *J. Wash. Acad. Sci.*, 31, 273–84; July, 1941), who has arrived at some very important conclusions. Older methods of determining the rate of heat production in particular specimens by examining the radon or thoron content were very cumbersome and thus few specimens were examined. Urry has taken a suggestion by the Director of the Laboratory and has examined a method of finding this rate of heat production merely by counting the rate of alpha particle emission in an ionization chamber. He finds that

$$H = 2{\cdot}1 \times 10^{-9} N,$$

where H is the heat produced in calories per gram of specimen per year and N is the total number of alpha particles emitted per gram per hour from the specimen. Heat accompanying the disintegration of potassium must be added to this and is equal to $4{\cdot}3 \times 10^{-6}\, a$ calories per gram per year, where a is gm. K_2O per gm. of specimen. This equation is possible since an error of less than 5 per cent is introduced by taking a fixed thorium uranium ratio in all previously examined types of rocks (acid to ultrabasic) and meteorites (iron and stony) where this ratio ranges from 0 to 20.

The author has examined the question of the variation of this heat production in geological history, and estimates that no significant increase in heat production within the structure of the earth has occurred during the accepted age of the earth (2×10^9 years). Further, in the opinion of Urry, hitherto undetected radio-elements could contribute an appreciable quantity of heat only before $1 \cdot 5 \times 10^9$ years ago.

The new method should facilitate adequate rapid observation (geothermal problems) of great numbers of rock specimens, and should thus in due course present us with a mass of observational data for the study of the influence of heat derived from radioactive materials on the thermal history of the earth, besides contributing data to assist in the solution of present geotectonic problems.

BEHAVIOUR OF SULPHUR IN RUBBER

According to G. G. Winspear (*Bell Lab. Rec.*, 20, No. 8, April, 1942) vulcanized rubber may have a wide variety of characteristics depending on the amount of sulphur, the period and temperature of vulcanization, and the other substances compounded with it. Identical rubber compositions, vulcanized for the same time and at the same temperature, do not always develop the same characteristics. One of the unsatisfactory conditions that sometimes appears is spottiness, indicating a lack of homogeneity in the product. Before the sulphur assumes a position in the rubber molecule, it dissolves, and to secure uniform solution the sulphur is first dispersed evenly throughout the rubber mass. When sulphur and rubber are mixed on a mill the sulphur is dispersed throughout the rubber mass but most of it is in particles of measurable size. Although the particles may be small, and perhaps even invisible to the unaided eye, they are still very large compared to the sulphur molecule, so that the mixture is far from being one where all the sulphur is in immediate contact with the rubber molecules, which is the theoretical state required to give a homogeneous solution of sulphur in rubber. Such an intimate mixture results from a diffusion of the sulphur of each particle following the dispersion on the mill.

If rubber including a small percentage of sulphur is thoroughly mixed and then held for a long enough time at a high enough temperature, all the sulphur will go into solution. From its original particles the sulphur will diffuse until the whole mass of rubber is thoroughly permeated, and if the temperature is high enough all the sulphur will be dissolved. Rubber in thin sheets with completely dissolved sulphur is clear and transparent while if it contains undissolved sulphur crystals it will be cloudy. After a known amount of sulphur has all been dissolved in a sheet of rubber some of the sulphur will begin to crystallize out if the temperature is lowered sufficiently, because the lower the temperature the less sulphur will the rubber dissolve. This precipitation of sulphur will be evidenced by the fact that rubber will take on a cloudy appearance.

The interval between mixing and vulcanization is also important. At the end of the mixing period the rubber is at a fairly high temperature and the amount of sulphur in solution will correspond to this temperature. If the rubber is now set aside it will cool and some of the sulphur will crystallize in fine structure dendritic form. When the rubber is again heated in the vulcanizing process the crystals go back readily into solution. If the rubber is allowed to stand for a more extended period before vulcanization, however, the dendritic crystals gradually change to larger rhombic sulphur crystals, so that when the rubber is vulcanized, the sulphur thus crystallized cannot as readily get back into solution because of the time required for completely dissolving these larger crystals. The formation of these rhombic crystals is undoubtedly the cause of some of the spotty conditions sometimes found in vulcanized rubber.

ELECTRICAL ENGINEERING IN THE UNITED STATES

Archer E. Knowlton, associate editor of the *Electrical World* (United States), in a review (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 18, June, 1942) of electrical engineering progress in the United States during the past 2–2½ years, points out that in 1941 and after, investigation and research have been redirected substantially towards military measures. Many developments arising out of the pressure for superior arms of every description are already regarded as having great import for the resumption of peace-time pursuits. Weights of electrical equipment are likely to be reduced as the results of iron research, and working temperatures of many kinds of equipment may be increased on account of alloy research.

Outstanding in the latter half of the period under review were the incentives to standardize, to simplify, to eke out and to compensate, in order that suddenly taxed systems could meet the exacting requirements of defence loadings with the least drain on capital, production facilities and installation forces. Also, the technique of proofing overhead lines against lightning made it possible to render a single line practically as reliable in performance as double circuits had been. Higher speed circuit-breakers, reclosure, earth-fault neutralizers, protector tubes, counterpoises, arresters, insulation co-ordination for impulses were all factors in creating effective immunity to the surges which precipitate outages.

In the field of power distribution, reliability of service vied with the imperative need for conservation of capital, and these two somewhat contradictory objectives can claim the bulk of the developments in power distribution. Among these might be mentioned sectionalization of radial feeders, reclosure, networks, banking of secondaries, rebalanced transformer losses, extensive application of corrective capacitors, surveys of thermal margins of apparatus, unit substations, step regulators, improved cables, etc. Change and uncertainty of location of defence loads, as well as the provision of spares for emergencies, have more recently prompted a considerable adoption of portable substations and capacitor banks.

The paper reviews more particularly and in a very condensed form the developments which have taken place in large generators, power generation, transformers, transmission, circuit interruption, relaying, lightning, switching and substations, cables, insulation, capacitors, power distribution, instruments, electronics and electrostatics, motors and control, industrial applications, transportations, rectifiers, electrothermics and electrochemistry, welding, illumination, and certain miscellaneous developments.

ELECTROMAGNETIC WAVES IN METAL TUBES OF RECTANGULAR CROSS-SECTION

AN article by J. Kemp (*Electrical Communication*, 20, No. 2, 1941) shows how the attenuation of electromagnetic waves propagated through the interior of rectangular metal tubes is calculated by the familiar telephone transmission formulæ, the top and bottom of the tube being regarded as zigzag flat-strip transmission lines while the side walls, when suitably disposed, are regarded as transmission lines of another type. From the losses occurring in these lines, the attenuation offered by the tube is obtained in a simple manner. The general formula for the attenuation of all types of waves in metal tubes of all cross-sections has been established by Schelkunoff. Chu and Barrow have also derived attenuation formulæ for all types of waves supported by tubes of rectangular cross-section. The method so far followed has involved the computation of the energy flow in the direction of the tube and the power losses in the walls by means of the Poynting flux theorem.

Electromagnetic waves in metal tubes are characterized by two essential features. There is a minimum frequency below which no waves are supported by the tube. This minimum or cut-off frequency is determined by the shape and the size of the tube. As the wave-length of the cut-off frequency is of the order of the cross-sectional dimension of the tube, the frequencies of the possible waves—for air-filled tubes having dimensions in the centimetre range—are of the order of 10^9 c./s. and above.

The second feature is that there is either an electric or a magnetic intensity in the direction of propagation of the waves, that is, along the tube. For electromagnetic waves in free space the electric and the magnetic intensities are in planes at right angles to the direction of propagation. When, however, waves are restricted to the inside of metal tubes there is, in addition to the electric and magnetic intensities of the free-space waves, either an electric or a magnetic intensity in the direction of propagation. It is customary to use this additional property of these waves for their classification. When there is an electric intensity in the direction of propagation, the wave is designated an E-wave. When there is a magnetic intensity in the direction of propagation, the wave is designated an H-wave.

The article proceeds to the mathematics of the problem and it is shown that the method reveals the existence of a link between two seemingly disjointed branches of telecommunication: (1) telecommunication of the classical character, employing a 'circuit', that is, a system comprising a 'go' and a 'return' path, and (2) telecommunication through hollow metal tubes without a return path in the conventional sense. The final expression for the attenuation constant of waves propagated through hollow metal tubes is derived in a simple manner from the familiar equations for the attenuation of telephone lines, with due regard to the reflexion loss at the junction of dissimilar lines, and the numerical results obtained by the shortened method agree in every respect with those obtained by more elaborate means by other investigators. The simplicity of the method arises from the fact that the telephone transmission formulæ contain implicitly the concepts required in the detailed calculation by orthodox procedure.

FORTHCOMING EVENTS

Wednesday, July 8

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Discussion on "Cathode Ray Tubes".

Thursday, July 9

INSTITUTE OF SEWAGE PURIFICATION (at Friends House, Euston Road, London, N.W.1), at 2.30 p.m.—Dr. E. M. Crowther: "The Manurial Value of Sewage Sludges"; Mr. J. Hurley: "A Critical Review of Recent Work on Sewage Filtration". July 10 (morning), Visit to Rothamsted Experimental Station, Harpenden, Herts.

Friday, July 10

SOCIETY OF CHEMICAL INDUSTRY (at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Annual General Meeting; at 3 p.m.—Presidential Address.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "The Structure and Rotation of Galaxies" (to be opened by Dr. A. Hunter, Dr. H. A. Brück, Sir Arthur Eddington, O.M., F.R.S., Dr. H. Spencer Jones, F.R.S.).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE BUILDING DEPARTMENT of the Croydon Polytechnic—The Education Officer, Education Office, Katherine Street, Croydon (July 9).

LECTURER (WOMAN) IN PHYSIOLOGY, ANATOMY AND HYGIENE at the Dunfermline College of Hygiene and Physical Education—The Executive Officer, National Committee for the Training of Teachers, 140 Princes Street, Edinburgh 2 (July 10).

LECTURER IN PHYSICS—The Principal, Royal Technical College, Salford (July 10).

VETERINARY INVESTIGATION OFFICER—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (July 10).

TEACHER OF ENGINEERING SUBJECTS at the Redditch Technical School—The Secretary to the Worcestershire Education Committee, Education Office, Church Green West, Redditch (July 11).

GRADUATE ASSISTANT MISTRESS to teach General Science including Biology and Geography—The Principal, Technical Institute, Tunbridge Wells (July 13).

GRADUATE LECTURER IN MECHANICAL ENGINEERING SUBJECTS at the Denbighshire Technical Institute, Wrexham—The Director of Education, Education Offices, Ruthin (July 13).

LECTURER IN PHYSICS (MAN OR WOMAN)—The Registrar, North Gloucestershire Technical College, Cheltenham (July 13).

LECTURER IN COLOURING MATTERS—The Registrar, College of Technology, Manchester 1 (July 13).

VETERINARY BACTERIOLOGIST—The Registrar, King's College, Newcastle-upon-Tyne, 2 (July 20).

WATER ENGINEER AND MANAGER to the Corporation of Swansea—The Town Clerk, The Guildhall, Swansea (July 20).

ASSISTANT FOR WORKSHOP AND GENERAL ENGINEERING SUBJECTS—The Principal, Erith Technical College, Belvedere, Erith, Kent.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Ross Institute of Tropical Hygiene. Some Emergency Anti-Malarial Measures. By Sir Malcolm Watson. Pp. 8+8 plates. (London: Ross Institute of Tropical Hygiene.) [226

Annual Report of the Fitzwilliam Museum Syndicate for the Year 1941. Pp. 10. (Cambridge: Fitzwilliam Museum.) [226

Friends of the Fitzwilliam Museum. Thirty-third Annual Report for the Year 1941. Pp. 4. (Cambridge: Fitzwilliam Museum.) [226

Other Countries

Air Department: New Zealand Meteorological Office. Professional Note No. 1: Synoptic Analysis over the Southern Oceans. By C. E. Palmer. Pp. iv+38+39 plates. (Wellington: Meteorological Office.) [126

Forest Research in India, 1940–41. Part 2: Reports for Burma and Indian Provinces. Pp. iii+242. (Dehra Dun: Manager of Publications.) 3.12 rupees: 6*s*. [176

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ECONOMIC FOUNDATIONS OF A NEW WORLD ORDER

THREE reports of wide importance have appeared almost simultaneously: on "Reconstruction", by the Federation of British Industries; on "Post-war Industrial Reconstruction"; by the Association of British Chambers of Commerce; and on the "General Principles of a Post-war Economy", from the London Chamber of Commerce; with these should also be read a report entitled "Relations with Britain", based on the findings of a committee of editors of the American periodicals *Time, Life* and *Fortune*. The interest which American opinion is taking in post-war reconstruction is reflected in the speeches of her leaders such as Mr. Milo Perkins, of the American Board of Economic Warfare, Mr. Henry Wallace, the Vice-President, Mr. Cordell Hull and Mr. Winant. In Great Britain, Mr. Eden, Mr. Lyttelton, Sir Stafford Cripps and Mr. Herbert Morrison have not lagged behind their American colleagues either in sincerity or in boldness in expression of peace aims.

In broad outlook the three British reports are indeed encouraging. They call for a new outlook. "Quite clearly", says the Federation of British Industries, "we are on the threshold of a new world and the theories and practices of the past cannot be taken for granted in the future. . . . A new situation will have arisen and it will be necessary for industry to suit its methods to that new situation, and not merely to aim at re-creating the pre-war conditions. This does not mean that there should be a complete break with the past, but that changed conditions will, in some respects, need new methods and a positive policy to create them. Such methods will require a fresh outlook, a mutual readiness to face sacrifices, and the determination on the part of all to develop their maximum effort." The actual proposals of the reports, however, betray a spirit quite inconsistent with the courage and faith of their words. There is no hint of the new methods and positive policies, of international co-operation between primary and industrial producers, of a rising standard of life, the equation of consumption with production and not the restriction of production to available consuming power, of a fuller flow of international lending to develop the backward regions of Asia, Africa and America, and of the repayment of world debts in goods. They tend indeed to return to the theories and practice of a restrictive, not of an enterprising past. Anglo-American co-operation seems to be viewed with anxiety.

When set against the American report, the despondency of these reports is remarkable. Of the strength and resources of Britain they give no hint. The spirit and ability that have proved her salvation since the darkest days of 1940 are passed over as if of no account in the post-war world. Britain's greatest asset in her buying power is ignored. The value of research in agriculture is recognized, but as to industry, the Federation of British Industries report alone has a stray reference to the necessity of a most active policy of research to develop new types of exports and to obtain maximum efficiency. Our assets of scientific and technical knowledge and ability are silently discounted. Apart from a wise reminder that it will only be possible to preserve a reasonable standard of life by hard work, and by attaching as much importance to our obligations towards the community as to the rights we claim from it, there is scarcely a reference to the need for great technical efficiency, for more output per head and the development of new techniques and industries.

It is left to the American report to correct this false impression of a decadent Britain brooding over the past, and to assess her true contribution to the technique of economic progress. The assumptions on which the American proposal is based are accepted in theory, if not in practice, by all the British reports: that the United Nations will win a complete victory; that the United States will emerge as the strongest single Power in the post-war world; and that the least America will settle for is a world in which President Roosevelt's four freedoms are reinforced with a fifth—freedom for individual enterprise. With those assumptions goes the belief that there need be no serious post-war depression, and certainly no unemployment; that there need be no major war for a long time to come; that frontiers can be reopened; and that there can be room for both democracy and economic freedom—if the United States choose.

The recommendations are set forth possibly with even more dignity in an article in *Fortune* than by Raymond L. Buell in the report itself. There is frankness and poise, judgment without recrimination, sanity and vision. The first proposal involves the abrogation of the Monroe Doctrine. There have always been some Americans, from John Quincey Adams onwards, who recognized that the Monroe Doctrine was meaningless without the *Pax Britannica* maintained by the British Navy; none the less, a pronouncement of the collapse of isolationism should not pass unacknowledged, for it clears the way to the maintenance of an alliance of the United Nations, particularly with Soviet Russia, China and Britain, to police the post-war world until it is capable of policing itself.

The second proposal goes far beyond the British reports in vision and statesmanship—the proposal that the common security policy should be accompanied by a common economic policy—the creation of a free market area. This second recommendation is that the two countries should unite their economies at once in complete free trade, and allow complete freedom of mutual migration for their respective peoples. The creation of a free market area between Britain and the United States, probably by a joint declaration as a first step, with the creation of joint administrative machinery such as a joint foreign trade council, and accompanied by the elaboration of common demobilization programmes and parallel action to forestall depressions and to promote freer trade, are intended as steps towards a larger area embracing other nations, including the Dominions, which would be invited to join on the same or on special terms. The authors of this proposal are under no illusions as to its dangers or difficulties, but they are rightly viewed in an adventurous spirit and with creative minds not entrenched in the inhibitions of the past.

No real judgment is possible upon the British reports except against the background of the American proposals. Moreover, the latter have their counterpart on the British side in a Political and Economic Planning (P E P) broadsheet on "Anglo-American Economic Policy" which appeared at the end of April, the tentative conclusions of which are strikingly in line with the spirit of the American proposals. Of the three reports, that of the London Chamber of Commerce, though somewhat nebulous, comes nearest to the American proposal.

Starting with the premise that trade barriers are not themselves the disease but merely the symptoms of the disease, and that there is something radically wrong with our economic system, it submits that it is essential, if greater disasters are to be avoided, to change the system so as to ensure that international trade shall tend to raise the standard of living of the backward nations to that of the advanced nations. International trade should be used as a means of mutual aid and advantage to those participating, and competition both within a nation and internationally should be reduced from a life-and-death struggle to healthy emulation. International trade should be an exchange of goods and services of a mutually advantageous character and should not disturb that correct balance between industry and agriculture essential both for social stability and for the health and happiness of the community.

This report shows clearly some of the fundamental problems which must be solved in our attempt to equate effective demand with supply and to eliminate under-consumption: the elimination of the fear and hostility which have been the outcome and the cause of attempts to restrict trade by tariff barriers, subsidies and other measures; the more effective internal distribution of purchasing power; the unwillingness of the primary producing countries, consequent upon their industrialization, to receive imports of manufactured goods previously imported freely; the migration from over-populated to under-populated countries; and the strain which results from the existence of nations with different internal economic systems. There is a healthy note in the Chamber's observations on agriculture, which show that its support should be forthcoming for those measures of re-planning the land which the Ministry of Planning will assuredly be called upon to introduce. For all this, there is little that is positive in the recommendations of the report, which goes no further than to recommend the establishment of appropriate machinery to ensure that slumps may be forestalled through close co-operation between industry and the central bank.

The report of the Association of British Chambers of Commerce, in spite of the warm welcome to clauses 4 and 5 of the Atlantic Charter, with which it starts, is timid in places, but there are unmistakable signs of a new spirit and outlook breaking through its alarms. The Association is prepared, for example, to see the decimal system established as the universal ystem of coinage, and it urges the Government to ake immediate steps for the preparation of widepread schemes of colonial development and an exension of facilities for migration from Great Britain o other parts of the Empire. It presses for early steps to ensure the closest co-operation between the British Empire, the United States, the U.S.S.R. and ll our other allies to provide a more equitable disribution of food and raw materials and a more orderly control of the world movement of manufactured goods. Moreover, if the report is silent as to the need for industrial research and development, it reaffirms the recommendations of its earlier report on agricultural policy in regard to extending the scope of research and making its results more simply available. The importance of agriculture as a major industry is recognized, and adoption of a well-balanced mixed farming policy is recommended, leaving grain crops principally to be imported.

Of the three reports, that from the Federation of British Industries is the clearest in the presentation of the issues, although like the others it falls short of concrete proposals. The first point submitted is that whatever the future form of co-operation in policing the world may be, it is essential that the democracies and other peace-loving nations of the world should take a continuing and permanent interest in ensuring the maintenance of a sufficient force to curb aggression, and that they should be prepared to use that force without hesitation or delay. Otherwise any post-war economic structure will be founded on a quicksand. Reconstruction at the end of the War may be visualized as possessing three aspects. First, the humanitarian phase, that of the immediate relief of stricken countries by the provision and distribution of food, clothing and medical aid to avert famine and pestilence. Secondly, that of economic relief, covering assistance to prevent economic collapse, the restoration and maintenance of essential services, including public finance. The third represents the re-shaping of our own economic life in relation to the needs of other countries, and the elaboration of a system of international trade.

The first two are clearly matters for international collaboration, and, as Viscount Cranborne indicated in his reply for the Government in the House of Lords debate on post-war settlement on June 2, are already receiving the active attention of the Government. The Federation of British Industries in its report submits that co-operation with our allies during the War is the necessary starting-point for eventual wider international collaboration, but that continuing co-operation is also required, inspired by the will and determination to maintain it over a period of years ; it must be sufficiently close yet elastic to enable methods to be suited to unforeseen changes in conditions which may arise from time to time.

A basic principle of reconstruction is that of increasing world purchasing power, and the Federation recognizes that control and restriction of production cannot by itself form a basis for an increase in world prosperity. It submits that serious attention should be given to the development of the Colonial Empires and such areas as China, less from the point of view of the provision of primary products for world use than from that of encouraging developments likely to improve their standard of life. Again, the Federation submits that industry desires the prosperity of agriculture, which is necessary in the national interest, but that the post-war planning of industry, both in regard to home and to overseas trade, will be so vitally affected by the agricultural policy followed in Great Britain that it is essential, if industrial policy is to be on a sound basis, that a decision should be reached, with the least possible delay, as to the future agricultural policy of the country.

Despite an able analysis, the Federation makes no concrete suggestions in regard to the nature of that policy, and similarly its admirable discussion of the many factors involved in national reconstruction, of Government control of industry—the necessity for the continuance of which during the immediate post-war period is admitted—the finance and organization of industry, and of the home market, issue in scarcely one constructive proposal, if we except the attention directed to the important question of the financing of industrial development after the War. This is the more disappointing because the spirit and outlook of whole sections of the report are admirable and balanced, and indicate unmistakably how large is the Government's responsibility for giving a lead and guidance to industry in this matter of reconstruction. The future organization of industry should always be subject to the overriding principle that it must be in the national interest ; finance should be the servant of industry, and not the master—these are unexceptionable principles. But if industry is to take the part in determining its own future organization which the Federation believes it should, industry must not wait upon the Government to take the first step, but by considering all the implications of industrial organization must be prepared with schemes for the more permanent association of Government with industry, which will provide the safeguards required alike in the interests of the nation as a whole and for the stimulation of individual effort and enterprise.

The magnitude of the administrative problems involved in any aspect of reconstruction can scarcely be exaggerated, and the success of whatever measures of reconstruction may be initiated will largely depend on the personnel to whom their administration and execution are ultimately entrusted. In that lies the best hope for the future of the organization now being established for inter-Allied co-operation in the conduct of the War. As the machinery now serving our immediate war purposes brings together the administrators, industrialists and men of science of the United Nations, it prepares the way for the establishment of like machinery for the attack on common problems after the War. It assists the development of a common outlook and demonstrates the possibilities which lie before us when concrete problems are attacked. The new plans which have just been announced to complete the organization for the most effective use of the combined resources of the two countries are an impressive illustration of this.

The Combined Production and Resources Board has been set up under Mr. Donald Nelson and Mr. Lyttelton, and working in close collaboration with the Combined Chiefs of Staff Committee, to ensure the continuous adjustment of production to the ever-changing requirements of the military situation. The Combined Food Board will work in Washington under the direction of Mr. Wickard, the United States Secretary of Agriculture, and Mr. R. H. Brand, chief of the British Food Mission in the United States, proceeding on the principle that the entire food resources of Great Britain and the United States are to be regarded as a common pool about which the fullest information will be exchanged. It needs little imagination to see in such developments a token of the administrative network of international social services which will be required to save Europe from anarchy, famine and disease. Moreover, the treaty between Great Britain and the U.S.S.R. is clear proof that this emphasis upon the combined role of Britain and the United States in war and peace is no derogation of the part that must be played by other great countries. The Combined Food Board, for example, will co-operate with all the United Nations in the use of food resources, as well as collaborate with all the other interested nations in the world in the development, expansion, purchase and use of their foodstuffs.

The importance of making every step fit in with the wishes and interests of other countries is not easily overstressed. For winning the War, or the peace to follow, there must be a basis of all-round trust. The gravest danger is that of petty nationalism on the part of any single country or any single group in any country, and for all the new outlook and spirit in the British reports on reconstruction, they show evidence of a lingering of a nationalist outlook and of a tendency to maintain national claims. The broadsheet on planning issued by PEP is therefore specially welcome as evidence to the contrary of the acceptance in Great Britain and in the United States of international economic collaboration as the condition of a real peace, based on freedom from want.

What is required, according to the planning broadsheet, is the continuous working out, at all levels and on both sides of the Atlantic, of economic principles and methods able to show results in increased and more widespread consumption of goods and services satisfying human needs and in security for occupied populations. A promising approach would be for those interested on both sides of the Atlantic to try to agree on a broad statement of economic purposes, and to develop on this basis a realistic contemporary code of economic behaviour and a calendar of economic crimes. An authoritative international tribunal to deal with disputes as to the 'unfairness' of particular acts, some kind of standing Anglo-American combined economic adjustment board to keep policies aligned and to remove sources of friction, and some sort of general welfare staff, national and international, combining broadly the duties of the new British Production General Staff and those of a social security board are further suggestions.

It is possible to see in recent developments the germ of the organization from which such bodie might evolve. The broadsheet shows, however, wha is even more important—the need for creative thought, for courageous forward-looking minds. As to the hopes, the new outlook and new spirit which have already been aroused, there can be no question If reconstruction is ever to satisfy those hopes, and if there is to be built a new order in which the four freedoms are firmly enshrined, it can only be as men bring to that task determination, vision, courage and magnanimity commensurate with their hopes, and with the effort now being made to gain the victory which must first be won.

NATIVE MEDICAL PRACTICE IN AFRICA

Native African Medicine
With Special Reference to its Practice in the Mano Tribe of Liberia. By Dr. George Way Harley. Pp. xvi+294. (Cambridge Mass.: Harvard University Press; London: Oxford University Press, 1941.) 20*s.* net.

NATIVE African medicine is still an unexplored territory, and it is doubtful if any single individual can arrive at a sound evaluation of native medical practice in any particular area. This would require an entire mission of persons qualified in chemistry, botany, medicine, anthropology and a few other sciences. Nevertheless, a good deal of preliminary investigation has been accomplished by individuals. Thus in South Africa considerable progress has been made in the work of determining the active principles of native drugs and of studying them chemically and experimentally on animals. J. M. Watt and M. G. Breyer-Brandwijk in 1932 published a volume on medicinal and poisonous plants used by the natives of South Africa, with information on 1,713 species which had been investigated in various laboratories. In 1934, D. G. Steyn published a work on the toxicology of plants in South Africa, and in West Africa there is J. M. Dabziel's "The Useful Plants of West Africa", with notes on the medicinal use, by natives, of more than seven hundred species; and so on.

In the present work, Dr. Harley, a medical missionary who has lived for twenty years in the closest contact with the natives of Liberia, and in particular with those of the Mano tribe, makes a valuable contribution to the knowledge of native medicine in its broader aspect. Although he does not appear to include himself in the ranks of 'anthropologists', his work is as much a contribution to anthropology as it is to medicine. This is because native conceptions of disease and native curative practices are intimately bound up with religion and magic; indeed, in order to understand them, it is necessary to have a knowledge of the whole culture of the people concerned. Dr. Harley has this knowledge.

The Mano term for medicine is *nye*, and although there is a tendency to limit this term to rational measures for curing disease, "it is extended in a loose way to include poisons, fetishes, charms and even black magic. Anything with a hidden power under the control of the user is *nye*". To the Mano man he medical and religious or magical elements of *nye* are never completely separated, and if he cannot deduce a cause for a pathological condition from his own everyday experience, he looks for it in the supernatural.

Among Mano remedies which we would describe as rational are ointments, poultices, mud baths, sweat baths, eye-lotions, fumes for headaches, splints for fractures, incisions over abscesses, and the use of counter-irritants. The treatment for poisoning consists largely of emetics and cathartics, as well as the use of precipitants such as tannic acid and rubber latex. (Dr. Harley has very little to say about antidotes.) Surgery is limited to bone-setting, blood-letting by small, shallow incisions, circumcision and scarification of tribal marks—the last two being performed in the secrecy of the Poro and Sande Societies. There is also a practice closely parallel to our custom of performing an autopsy on cases in which the cause of death is obscure. The native leech will open up a cadaver and remove a diseased organ, especially if this organ had been the seat of a tumour which was recognizable before death and supposed to be witch-substance. The diseased organ will be removed and buried separately, so that the spirit of the deceased will not transmit the disease to some other member of the family.

Cases of smallpox are isolated, but inoculation is not practised by the Mano, though it is by numerous other tribes in West Africa. In some areas of Africa inoculations are also given against snake bite. In speaking of the widespread custom of drinking the ink used in writing verses of the Koran, Dr. Harley says that "the possible value of this ink must be attributed to the herbs from which it is made". But the practice is surely pure magic and nothing else. Again, in speaking of the practice of giving sun baths to babies, Dr. Harley observes that "whether this sunning is responsible or not, there were only three recognizable cases of rickets in a series of 8,291 admissions to the Ganta dispensary". But the cause of rickets is well established and sunning can scarcely be a cure.

Chapter 6 deals with the magical treatment of disease, and Chapter 7 with treatments that are partly rational and partly magical. "There is", says Dr. Harley, "no assurance that any particular remedy is used for its drug content, and not for some fanciful resemblance of leaf, seed, flower or thorn to the lesion of the organ which is the seat of disease. . . . Yet there is no doubt that most of the remedies included under the discussion of rational treatment have therapeutic value." But some critics might consider that no sufficient evidence had been adduced to justify this wide generalization.

The succeeding chapters deal with the treatment of snake bite, the Snake Society known as Ba Kona, and the Poro Society which is largely a 'medicine' society. There is a great deal of new information in these chapters. The treatment for snake bite is difficult to evaluate, being a mixture of the rational and the magical. Even the piece of bark tied above the wound would appear to be doubtfully described as a 'tourniquet', since it seems to be regarded as a 'ring' for warding off evil. It is said that members of the Snake Society catch and tame any kind of snake except the spitting cobra.

There is an interesting chapter on black magic and poison, and another on divination. The method of manipulating the well-known ordeal of boiling oil is explained. If the accused was to be found innocent, some water was added to the oil, the water stayed at the bottom of the pot and boiled first, giving the appearance of boiling to the oil while it was, in fact, still comparatively cool.

In his summary of diseases showing types of treatment differentiated as 'rational', 'magical' and 'mixed', Dr. Harley estimates that 65 per cent of the diseases have treatments which are clearly rational. Only thirteen out of ninety-nine diseases are lacking in any indication of at least partly rational treatment. But the system of classification is scarcely scientific, since many of the native names for diseases are merely rough descriptive phrases. It cannot be supposed, for example, that there are special native treatments for 'liver abscess' or 'malnutrition'.

The book concludes with a valuable supplementary chapter on native medical practice in Africa as a whole, and there are also a bibliography and a botanical list of the plants mentioned in the text. The bibliography omits a number of books which Dr. Harley could have used to advantage. Meek's "A Sudanese Kingdom", for example, should have been included, as this contains an entire chapter devoted to medicine and witchcraft among the Jukun of Nigeria, who appear to have a great deal in common with the Mano and even to share some of their terms. Another noteworthy omission from Dr. Harley's work is any discussion of the phenomenon so characteristic of West Africa, namely, 'possession'.

These criticisms do not alter the fact that Dr. Harley has provided a first-rate text-book on native African medicine.

THERMODYNAMICS AND CHEMICAL ENGINEERING

Thermochemical Calculations

By Dr. Ralph R. Wenner. Pp. xii+384. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 28*s*.

THE application of the concept of equilibrium to industrial processes involving gaseous reactions and changes of state has met with such success as to encourage a more extended use of the thermodynamic method in other directions, and numerous attempts to do so have been recorded in the literature in recent years. A great deal of ingenuity has been expended in overcoming some of the more obvious limitations of the method; for, apart from the lack of essential data, there are difficulties of a fundamental kind due to the fact that no 'real' system is in true equilibrium with respect to all the possible changes which may occur within it; and industrial processes generally include a time factor which is not taken into account in the thermodynamic treatment.

It can be seen, therefore, that Dr. Wenner has set himself a formidable task when he undertakes to satisfy the investigator who, "attacking problems of pure and applied science, seeks the specific thermodynamic methods which are applicable to his problem and the data requisite for its solution". It is only fair to say that he succeeds better than might have been expected. The reader may regret certain important omissions from the theoretical part of the book and he will recognize the practical difficulties which have led the author, on occasions, to adopt procedures which, at best, must be regarded as dubious. But he will also pay tribute to the care which has been taken in the selection and working out of problems illustrating unit processes in nearly every branch of chemical technology.

The notation and theoretical treatment employed throughout the book are those familiar to American students. The fundamental thermodynamic quantities chosen are the "characteristic function"—total energy, with the independent variables, entropy, volume and chemical content; the remaining functions are then expressed in terms of the characteristic function and its differential coefficients with respect to the three variables. The earlier chapters deal with the thermal effects accompanying changes of state, solution processes and chemical reactions and with equilibria.

One of the essential requirements in applying the thermodynamic method is to be able to predict with some certainty changes in the values of the appropriate functions over a wide range of experimental conditions. In most instances this may be done from a knowledge of the heat capacities of the components of specific systems between the absolute zero and the working temperature, the enthalpy changes associated with any changes of state occurring between these two temperatures and the heat of formation of each component at some stated temperature.

The significance of these changes, particularly in systems of more than one phase, is by no means obvious from tabulated data, and simple graphical representation is to be recommended wherever possible. It is to be regretted that Dr. Wenner neglects this method. In the chapter on the liquefaction of gases, for example, processes of refrigeration, compression and expansion are worked out by the aid of thermodynamic relationships and formulæ, which are cumbersome to use and fail to give any clear picture of what is happening. The construction of the relevant thermodynamic diagrams, on the other hand, is not difficult and constitutes a most instructive exercise for students; it merely consists in selecting any two of the variables p, T, H, S and V as co-ordinates and plotting a series of curves along which the other properties remain constant. It is immaterial which pair is chosen since, in principle, all such diagrams are equivalent, but for general purposes the (H,T), (T,S) and (H,S) diagrams are the most convenient. Data for most industrial gases are usually available or may be calculated with sufficient accuracy by well-known methods.

In dealing with physical and chemical equilibria methods based upon the concepts of 'fugacity' and 'activity coefficient' are employed. These quantities are evaluated from experimental data or from an appropriate equation of state. In recent years redeterminations of the compressibilities of all the more commonly employed gases and vapours have been carried out with a degree of accuracy sufficient to permit of the graphical computation of such derivatives as $(dv/dp)_T$, $(dv/dT)_p$ and $(d^2v/dT^2)_p$. The isothermal data may be expressed by empirical series equations in which the product pv is developed in terms of powers of p with the requisite number of constants to cover the whole range of the experimental observations, or by semi-empirical equations of state in which the constants are fewer in number and can be assigned some kind of physical meaning. Dr. Wenner favours the latter; but there is little to choose between the two types, provided always it is understood that they are valid only over restricted ranges of temperature and pressure. Where no experimental data are available, the law of corresponding states (based upon an equation with two constants) can be used to give a rough estimate of compressibilities.

From a knowledge of the sign and magnitude of the free energy and entropy changes resulting from a specific process carried to completion, and the corresponding figures for any secondary processes which may occur simultaneously within the reacting system, it is possible to fix within reasonable limits the temperature and pressure likely to favour the change it is desired to bring about. In this connexion two chapters are devoted to indirect methods of estimating free energies and entropies based upon the Third Law and upon the statistical interpretation of entropy.

The chemical engineer, however, has not only to assure himself of the thermodynamic possibility of such a process, but also to decide whether the physical or chemical changes involved in it can be made to proceed at measurable and useful rates under practical working conditions. As already mentioned, thermodynamics fails to give a conclusive answer to this question; but it does afford indications which enable a forecast to be made of the factors most likely to influence the result in the desired direction.

As Dr. Wenner rightly points out, there is scarcely any instance in which the complete elimination of the preliminary thermodynamic analysis of a problem in chemical technology can be justified by the absence of essential data; and he emphasizes this view by suggesting wherever possible alternative indirect methods of computing thermodynamic functions from molecular structure, spectroscopic and other physical data.

The book concludes with a section containing some sixty unsolved problems suitable as class-room exercises.

D. M. NEWITT.

'NEW LAMPS FOR OLD

What the Future Demands of Religion

By R. F. Delancey Wellbye. Pp. ix+182. (London: Watts and Co., Ltd., 1942.) 5s. net.

THE question which Mr. Delancey Wellbye sets at the beginning of his book, and answers in the affirmative, is this: "If God and an after life are set aside as probably unprovable but anyhow irrelevant to the conduct of this life, and if the miraculous is discarded as incredible and needless, do the elements of a satisfying and sustaining religion exist?"

Mr. Wellbye finds such a satisfying and sustaining faith in an evolutionary philosophy, for which the universe, and especially our world, is 'intensely dynamic', and for which the human individual, caught up in the cosmic drive, is the growing-point of progress. Man is part and parcel of the creative evolutionary process, its agent as well as its offspring, fulfilling his nature by co-operating with it. Man's nature is fourfold: he is a creature that (1) reflects, (2) feels himself to be a 'self' with an inner life that matters more to him than the outside world, (3) is co-operative and friendly by nature, and (4) has a personality which is not something given or fated, but continually enriched and changed by absorbing experiences. It is by developing these various potentialities that man enriches his personality and so becomes actually the dominant form of cosmic activity. Mr. Wellbye claims that "This vision of a universe in action, and of man within it, its agent and destined in all likelihood to become the dominant form of cosmic activity on this planet—this is a vision by which man can live, finding life good, and proud in the faith that human and cosmic destiny entwine".

Such being Mr. Wellbye's philosophy, his ethic is realistic. Goodness is appropriate action—action naturally taken if the circumstances are envisaged as they actually are, and not simply as they appear to a vision limited and distorted by self-interest. If conduct is based on valuations or estimates of fact which are false, disaster inevitably follows, for successful action proceeds from a proper adjustment to reality. Thus desire has to be revised and corrected in the light of understanding, which is defined as "the ability to see through the meaningless world of appearance to the significant world as it is in relation to human activity". Thus Mr. Wellbye's scheme of things gives an absorbing purpose to human life and bases conduct upon an understanding of reality.

It will be seen that the view of humanity outlined in these pages is a favourable one, and this in spite of the strong temptation which present circumstances offer to take a contrary view. Unfortunately, much orthodox religious apologetic is now taking the pessimistic point of view, which is also the obvious one. Mr. Wellbye does not base his views on mere sentimentalism but on the anthropological researches which have exploded the popular myth that primitive man was a savage cave-dwelling individualist, but established him rather as a kindly co-operative creature, who had to be educated in cruelty by civilization. That our own civilization educates us in egoism can scarcely be denied. If institutions are the product of man, it is no less true that man is also the product of his institutions.

Mr. Wellbye, though one can sympathize with his motives, is possibly less than fair to the traditional religious point of view; for example, we doubt if any instructed Christian would really hold "that what is good and what is wicked in human conduct rest finally on the arbitrary will of God". He would be much more likely to say with Mr. Wellbye himself that morality is behaving in accordance with the nature of things, about which there is certainly nothing arbitrary. Nor is it historically true that "the Christian Church has invented the category of sin". Sin is indeed a specifically religious and not merely a moral conception, but it is one which was widespread in the pre-Christian period, as the works of Prof. Angus, whom Mr. Wellbye names in his bibliography, show. The fact that the idea has been over-stressed does not divest it of truth. Mr. Wellbye emphasizes the importance of sensitiveness as a means of enriching personality; and the absence of all 'sense of sin' is a form of moral insensitiveness. It is not only physical ills, such as a toothache, that make a normal man feel uncomfortable. Mr. Wellbye also speaks of the capacity to absorb and use our experiences so that they change us; one of the positive achievements of the traditional religion has been that it has enabled people to convert adverse and disagreeable experiences into a means of enriching life and endowing it with new graces. There are those who, "going through the vale of misery use it as a well, and the pools are filled with water". Too many critics of the traditional religion have failed to recognize that it has satisfied a far larger variety of human needs than has any *ad hoc* system of ideas. Christianity is a pool where elephants may swim as well as lambs drink, and seems a different place to either. Perhaps Renan was not far wrong in saying that few people have the right to disbelieve in it.

The fact is that the constructive half of Mr. Wellbye's book is better than the critical half; and that is a good deal more than can usually be said of books of this character. His attempt to outline a new way of looking at things (which is perhaps not so new after all) is vigorous and stimulating.

J. C. HARDWICK.

HIGHER ALGEBRA

The Tutorial Algebra

By Dr. William Briggs and Prof. G. H. Bryan. Revised and rewritten by Dr. George Walker. Vol. 2: Advanced Course. Fifth edition, revised and rewritten. Pp. viii+599. (London: University Tutorial Press, Ltd., 1942.) 12*s.* 6*d.*

THE first volume of this standard work, published in 1940 in a revised and rewritten form, covered the algebra prescribed chiefly for the intermediate examinations of the University of London. The present book takes the work to a higher stage, and this additional volume was rendered necessary owing to the rapid expansion of the subject and, therefore, the need for the incorporation of a large quantity of new matter.

Volume 2 carries the course from infinite sequences and series to the theory of equations. The more advanced algebra required for London Intermediate Economics Examination and by students preparing for the several Higher School Certificate examinations is thus adequately provided in 542 well-filled pages of clearly written text. The binomial theorem, the exponential and logarithmic series, convergency, complex numbers, recurring series, summation, determinants, elimination and the theory of equations are all dealt with in a rigorous, comprehensive and skilful manner. The principles developed are excellently illustrated by aptly chosen examples, and the methods of solution are, in general, models of conciseness and elegance.

Indeed, in so many ways is the treatment so good that even more would seem to be desirable. This is particularly the case in the consideration of the biquadratic, although reference for more detailed discussion is given on p. 508. From a practical point of view, the quartic equation is becoming of increasing importance; yet rarely is a complete analysis of it to be found. It is therefore somewhat disappointing to find that no real development of the discriminant of the quartic, like the corresponding treatment of the cubic, is included in this valuable book. Incidentally, example (2) on p. 510 appears to require some clarification. Is the condition $ac-b^2>0$ sufficient to indicate the presence of at least two imaginary roots in a given biquadratic? The equation, $x^4-4x^3-35x^2+122x-168=0$, has two real roots, -6, 7, and two imaginary roots, $\frac{1}{2}(3\pm i\sqrt{7})$; yet $ac-b^2$ is negative.

Only one other point need be mentioned: this concerns the determinantal equation on p. 511 which yields the reducing cubic in $\lambda\lambda'$. As the text reads, the student is given no hint that this equation is the eliminant of the separate coefficients, λ, λ', μ, μ', after each of these has been expressed in terms of the unknown $\lambda\lambda'$.

However, apart from these points and the few misprints noticeable, the revised edition of this work can be confidently recommended as a thoroughly good and sound course in modern algebra.

F. G. W. BROWN.

Handbook of Technical Instruction for Wireless Telegraphists

By H. M. Dowsett and L. E. Q. Walker. Seventh edition, extensively revised and enlarged. Pp. xx+664. (London: Iliffe and Sons, Ltd., 1942.) 25s. net.

IN such a rapidly-growing subject as radio communication, a technical book which has survived to a seventh edition must first have possessed a very sound basis in its original form, and secondly it must have been very wisely kept abreast of the subject by its authors. All wireless operators of the pre-1914 vintage will remember the first edition by J. C. Hawkhead; this book was a standard work of its time for all would-be operators studying to qualify for the Postmaster-General's certificate. The latest edition maintains the traditions of its forerunners in providing for operators and engineers a complete course of instruction in the general principles and practice of marine wireless communication.

The work has been brought as fully up to date as is possible in a field that is not infrequently disturbed by novel applications of a somewhat revolutionary nature. It deals with the whole range of a ship's communication equipment from the power supply to the transmitting aerial, and from the crystal detector or valve receiver in a small ship to the elaborate loud-speaker installation and public address system in a luxury liner. The technical treatment also covers such aids to navigation as direction finding, depth sounding and distress call apparatus. One of the main features of the book is the large amount of photographic and circuit diagrammatic material given on all types of commercial radio-marine equipment in use at the present time. In view of the somewhat long life possessed by some of this equipment, the authors appear to have overcome successfully the difficult task of replacing obsolete material by descriptions of current designs, without making the resulting book unduly large.

The volume may be thoroughly recommended to all who are concerned with marine radio communication, not only to assist them to pass their qualifying examinations, but also as a work of reference during their active careers.

A Check-List of British Birds

With a Short Account of the Status of Each. Revised edition. Compiled from "The Handbook of British Birds". By H. F. Witherby. Pp. 78. (London: H. F. and G. Witherby, Ltd., 1941.) 5s. net.

AS a companion to the "Handbook of British Birds" (five volumes), the small but valuable "Check-List of British Birds" has just recently been prepared by Mr. H. F. Witherby. This list of British birds is reprinted from the "Handbook": it is set down in the briefest possible form; for fuller particulars the "Handbook" itself must be consulted. No fewer than 424 species of birds have been admitted to the British list; of these, 219 species have bred in Britain during the present century.

The "Check-List" is clearly printed, on excellent paper, and will prove a valuable addition to the list of ornithological publications.

On p. 42 is a printer's error which may perhaps be altered in a future edition. Here it is stated that the osprey last bred in Scotland in 1902. For 1902, the year 1908 should be substituted. The last accepted nesting of the osprey in Scotland (although there is a possibility that the species has bred later) was in the year 1908, on Loch Arkaig in Inverness-shire. Cameron of Lochiel, on whose property these ospreys nested, writes to me as follows: "The Ospreys nested on Loch Arkaig in 1908. One solitary bird returned for five years afterwards, and was last seen in 1913. I believe this bird was shot in Ireland, as I myself saw a stuffed osprey in the south of Ireland, and was told that the bird had been shot in 1913. In 1907 there were three young birds in the Loch Arkaig eyrie. In 1908 the eggs were stolen."

Ospreys still visit the Highlands of Scotland on migration, and it is possible that one year a pair will remain to nest in some tree or ancient castle of an ancestral loch. SETON GORDON.

Short Wave Wireless Communication

Including Ultra-Short Waves. By A. W. Ladner and C. R. Stoner. Fourth edition, revised and enlarged. Pp. xv+573. (London: Chapman and Hall, Ltd., 1942.) 35s. net.

THIS now well-known technical book was first published about ten years ago, and the fact that a fourth edition has become necessary shows that its popularity is being well maintained among the constantly increasing number of radio communication engineers and physicists. A notice of the third edition appeared in NATURE of November 14, 1936, and it is noted with some satisfaction that the opportunity has now been taken to re-arrange the chapters in a more suitable manner.

In so far as the censor will permit, the whole work has been revised and brought up to date to form a comprehensive treatise on the technical principles and application of radio telegraphic and telephonic communication on wave-lengths less than about 100 metres. A chapter entitled "Electron Oscillators" contains much new material on the various types of oscillators available for the ultra-short wave-lengths less than 10 metres. A new chapter deals with high-frequency therapeutic apparatus, and attempts to present in a clear manner the facts, as well as the very controversial claims, covering the application of high-frequency radio apparatus to medical treatment.

This new edition of the book deserves to have continued success.

Brompton Hospital Reports

A Collection of Papers recently Published from the Hospital. Vol. 10, 1941. Pp. vii+127+29 plates. (London: Brompton Hospital, 1942.) 5s. net.

WITH the exception of a paper on the "Persistence of Lipiodol in the Lungs after Bronchography" all the articles in these reports, of which Dr. Maurice Davidson has succeeded the late Dr. Bosanquet as editor, have previously been published in various medical periodicals. Three of the ten articles are of special interest at the present time, as they are devoted to chest surgery in war, while the rest deal with the etiology of subacute pulmonary infections and erythema nodosum, the medical aspects of chronic empyema and tumours of the lungs. An authors' index to the first ten volumes, a subject index to the first nine volumes, and a subject index to the present volume are appended.

FUTURE OF THE MILK INDUSTRY*

By PROF. H. D. KAY, O.B.E.
Director of the National Institute for Research in Dairying

THE future of the milk industry in Great Britain is the key to two matters of extraordinary national importance. Its future is, by and large, the future of national nutrition ; its future is, no less, the future of British farming. An expanding milk industry is our best guarantee of a steady improvement in the health and physique of the rising generation ; a declining milk industry would foreshadow the rapid re-entry of British farming into the Slough of Despond. The future of the industry is not a thing to be regarded as starting after the War. It is starting now, and developments taking place to-day and during the War are influencing and shaping it continually. In fact, the War is catalysing valuable changes in the industry which might otherwise have taken years to accomplish, though slowing up other desirable developments that some of us had hoped to see before now.

The milk industry includes what is, in terms of money value, nutritional significance and numbers engaged, the greatest of our agricultural enterprises, that of dairy farming (having at the present time a turnover of some £100 millions a year), together with one of our major home industries, that of milk processing and distribution (having a turnover of some £150 millions a year). Technically, administratively and educationally, this large industry must in the future be regarded as one unit. For present purposes I shall not consider the closely related industries of cheese, butter and ice-cream manufacture, or the large ancillary trades concerned with the preparation of cattle feeding-stuffs.

Need for Planning

Freedom from want entails forethought. Our cave-dwelling ancestors, rugged individualists all of them, may have spent a happy summer and autumn under the greenwood tree and fairly full of food, but their winters must have been extremely thin and meagre before they began systematically to plan their food supplies ahead and to till the soil.

The major half of agriculture—and by agriculture I mean continuous agriculture and not the crop snatching that has terminated in certain parts of the world in complete loss of fertility, or even in loss of the soil itself by erosion—is forethought and planning, planning not for a year, but for several years ahead. The producing side of the milk industry, founded on the all-the-year-round consumption of agricultural products by livestock, is an activity where careful planning ahead is particularly important. The matings occurring this spring are laying the foundations not merely for next winter's milk production but also for our milk supply in 1945. The education that we are giving—or not giving—our potential dairy farmers to-day is securing efficiency or piling up trouble for the 1950's and 60's. Unless we are completely dead to all the lessons which peace ought to have taught us and which the War is daily and rather painfully underlining, we must all be agreed that one of the fixed points for any post-war milk industry is that it must be organized as a unit.

Objectives of the Milk Industry

A planned system must have an objective. The primary function of the milk industry is now, and will continue to be after the War, to produce and distribute effectively, to all human beings who need it, when and where, and in what quantities they need it, and in the highest possible quality, a key foodstuff that is essential in certain stages of human life and of major value at any stage. Its secondary function, requisite for the performance of the first, is to provide a reasonable living for those engaged in the industry. The acceptance of this view with its stress on the meeting of human nutritional needs as the primary object of the milk industry means a fundamental change in the habits of thought of some of us, and has many implications which I cannot pursue now. One assumption, however, I must make, that any future Government of Great Britain will take over the mantle which the present Government is, I think, the first effectively to wear, in insisting that the steady improvement of the health and physique of the people, particularly of the rising generation, and the promotion of British agriculture, are two of their main and closely interlocked duties. Milk is central in both of these.

We are in the fortunate position that we can *now* give to the industry a fairly close estimate of our future national needs. As a result of a large body of experiments and surveys extending over the past twenty-five years we now know sufficiently well what is the average quantity of milk per head of the population that is needed for adequate nutrition, that is, needed to raise the nutritional level of our people to that at which optimal physical growth and development and general health (so far as they depend on nutrition) may be attained. It is not less than 0·8 pint per head per day, probably not less than 1·0 pint. At present our average consumption is just over 0·4 pint per head per day. This figure is slightly greater than the amount in Great Britain in pre-war days, but slightly less than that consumed in the very poorest of American cities.

On a yearly gallonage basis, 0·8 pint per head—taking the lower of the figures just mentioned—means 1,650 million gallons a year. Liquid consumption is evenly distributed over the whole year, so that about 140 million gallons per month, winter and summer alike, will be needed. This means a 75 per cent increase in present *winter* milk production, though only a 30 per cent increase in summer production, assuming practically no milk for manufacture.

Two objections will rise to everyone's mind. First, will not the population, even if it has the money to buy the milk, slip back after the War into the peace-time habit of a low milk demand, so that any increase in production will merely mean more to be manufactured ? The second question is, will not the post-war home dairy farming industry and the purchasing power of our population both be too severely hit by war impoverishment to hope to attain anything approaching this level of supply or demand ? My reply is that it would be most unwise to underestimate the speed of recovery both in general economic level and in agricultural developments of an adequately mechanized civilization like our own provided we win the War, and provided we manage to canalize, in a socially positive direction both the enormous industrial forces and the great psychological drive that will be liberated when peace is declared.

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* Substance of a paper read before the Royal Society of Arts on May 20.

Could any part of these requirements be met by the importation of dried or condensed milk? Undoubtedly, but in relatively small part. To provide a year's supply some 800,000 tons of dried milk would be needed. The Southern Dominions, working all out on milk drying, might provide one-twentieth of this amount. Even if dried milk in the necessary quantity, flavour and ease of reconstitution could be imported, a good deal of persuasion would, in my opinion, be needed before it could be used in the household on any impressive scale. In bread and confectionery making, in the institute, canteen or restaurant, dried milk could readily be used to the limits of any visible or likely supply.

Increased Efficiency of Dairy Farming

To meet the liquid milk demands I have just envisaged, most dairy farmers in these not very large islands will have to increase their efficiency and improve their management very considerably.

The yield of milk per cow per year offers a wide field for improvement. From the 520–550 gallons of the pre-war years (now down to about 460) it could be raised in a decade or so by the use of knowledge we already possess (perhaps most rapidly by taking every advantage of artificial insemination from first-class sires) to 700–750 gallons. That this is a reasonable estimate of what can be done is supported by the fact that the yield per cow in Denmark some ten years ago was officially stated to be 704 gallons per cow. Further, by control, much of which is now possible, of sterility and other bovine diseases, the average length of milking life of a cow, now less than four lactations, could be steadily raised to six, seven or even more. Instead of being a very rare creature, the 5,000-gallon cow (that is, an average of about 700 gallons for seven lactations) would be found in most herds. To enable this objective to be more rapidly reached, not only must existing knowledge be rigorously applied, but also research in the control of cattle diseases, and particularly the physiological and pathological study of bovine sterility, pressed forward with renewed energy when some of our more immediate war tasks are ended.

We shall have to control more carefully the type of bull to be used in dairy herds. Any future scheme for the use of better sires will undoubtedly receive the hearty support of the milk-producing industry. It is of interest to remember that the Ministry scheme for licensing bulls, which was rather unwisely allowed to lapse at the outbreak of war, was put into action again at the urgent request of the farmers themselves. The use of any bull inferior to the son of a proved sire out of a high-yielding dam ought, in fact, to be increasingly discouraged in the future in any herd pretending to be a dairy herd. In addition, a simple system of milk recording, without which no dairy farmer can effectively plan his feeding, breeding or culling programme, will have to be made, if not universal, as near universal as makes no matter.

Present milk shortage is due as much to lack of knowledge as to lack of feeding stuffs. Next winter's milk production, as well as that in the post-war future to which I have been referring, depends largely on the more general practice of modern—which are at the same time economical—methods of feeding. It is to be noted that per unit of feeding-stuff consumed, the 700-gallon cow is much more efficient than the 500 galloner.

After the War, if we are able to return to, and to pay for, the importation of sufficient animal feeding-stuffs, the solution of the milk producer's winter feeding problem will be relatively easy. In any case we shall probably have to continue in part on the fundamentally sounder lines along which the War has driven us—the production of *better-quality protein-rich* feeding-stuffs at home. Of these, the major ones for milk production are still good leafy grass during the growing season, which will, in the future, be extended on the average by a fortnight at each end, hay cut at a relatively early stage with as much clover in it as possible, and well-made silage from young grass or from an oats and pulse mixture. Young grass and grass products will probably continue for some years to be our main protein-containing foodstuffs for the dairy herd, and the basic knowledge that has been acquired in the last two decades as to how to improve productivity and stock-carrying capacity of grassland should enable us to meet increasing demands for the milk-production ration without encroaching too severely on other types of farming or upsetting farming balance.

Increase in Cow Population

Even if we succeed in increasing the average yield per cow from the pre-war 520–550 up to 700–750 gallons, it will only give us about 40 per cent of the increase in milk production that we require to meet human nutritional needs. In addition to increased individual yield, there will also have to be an increased dairy herd. From the present population of a little more than 3,200,000 cows and heifers in milk and in calf, it will have to increase to nearly 4½ millions.

As a result of improvements in grassland and grassland management, better knowledge of arable cropping for milk production, increasing soil fertility as the manurial output of the increasing herd steadily rises, and as artificial fertilizers are used with greater skill, this population should require little more dairy-farming acreage than does the present relatively inefficient herd.

The more the farm is self-supporting as regards cattle feeding-stuffs, the more is it necessary to put back into the soil those minerals inevitably lost in every gallon of milk leaving the farm. Concomitant with an increased milk output is, therefore, an increased requirement for lime, for basic slag and other phosphatic manures, for potash and for nitrogen.

Larger Dairying Units

Not only will there be in the future a larger population of dairy cows per 100 acres, but the average dairy-farming unit will also increase very considerably in acreage, with a decrease in the total number of holdings. The average dairy-farming unit at present is only some 12–14 cows strong, but the greater efficiency of a larger unit, where both general and specialist machines can be used to advantage, overheads spread over a larger acreage, cropping policy planned on a wider basis, disease control managed more effectively, purchases made on more economical terms, better arrangements made as regards hours of work, holiday periods and so on, needs no emphasis. It is repeatedly stated that dairy farming is a particularly onerous job. This is true while the units remain small. But with a larger unit, say one having not less than 40–50 cows in milk, where three or four men or more may be available for cow-shed work, a little organization should make it possible for the duties of feeding, milking and day-to-day operations generally to be scarcely more onerous than those on any other type of farm.

Chartered Dairy Farmers

An organized and planned milk industry may demand in the not too distant future standards of professional competence before would-be entrants into dairy farming are allowed to use land at all. It may also insist on the squeezing out into some other avocation in which he will do less harm, of the incorrigibly dirty and inefficient milk producer. Modern dairy farming demands, in no small measure, relatively new knowledge which should be a minimum asset of any who hopes to have the privilege of using a portion of our limited farming area to the best national advantage. The idea of the chartered dairy farmer is not so visionary as it sounds. Meanwhile, until vocational farming education on modern lines —which means, of course, no educational stunt, but the combination of new knowledge with ripe and tested experience in an organized course of training —can be extended to cover the needs of the large majority of new entrants into the farming profession (instead of only about 10 per cent of them as at present) the appointment in all our dairying counties of competent dairy husbandry advisers is highly desirable.

Improved Quality of Milk

The future of milk quality has three aspects: that concerned with ordinary hygiene and cleanliness, that concerned with udder disease, and that concerned with compositional or nutritional quality. All these are closely linked up.

As regards cleanliness of production, absence of which leads, particularly in summer, to taints and souring, perhaps 50 per cent of farmers, mainly those who have been producing milk for some time and have learned the simple routine for avoiding contamination, turn out a consistently satisfactory article. As regards udder diseases, methods are now known for controlling the most important of these, streptococcal mastitis, and the national veterinary medical plan which is being put into practice on a voluntary basis should, if combined with an increase of the farmer's knowledge as to the simple methods he can himself use in the cow-shed to limit its spread, be of great assistance in diminishing the heavy toll of this disease on the quantity and the nutritional quality of our milk supply. As regards *compositional* quality of milk, practically no official attention has ever been given in Great Britain to the poor nutritional value of much of our market milk, to the great changes in its nutritive quality that may be brought about by changes in the nutrition of the cow, or as a result of chronic udder disease.

Disease

I have just mentioned one of the directions in which bovine disease affects the dairy farmer. Disease puts a gratuitous tax of at least 25 per cent on to the economic cost of every gallon of milk. Diseases, like tuberculosis and contagious abortion, which can cause human infection if the milk containing the organisms is consumed, are far less important from the consumer's point of view now that more milk is pasteurized, but are extremely important from the point of view of the dairy farmer, since they may easily ruin a first-class herd unless early recognized and checked. Some form of obligatory national veterinary health insurance seems likely in the fairly near future, together with an efficient State system of preventive veterinary medicine.

Distribution

Assuming that milk of satisfactory compositional, hygienic and keeping quality has been produced by our future dairy farmer, let us consider the next steps. He will either deliver it himself to the buyer, or more usually have the churns called for either at his farm or at some convenient place on the roadside, by the collecting lorry attached to the local collecting depot or distributing dairy. In the future the churns will contain cooled milk, well below 65° F. when they leave the farm, and will be placed, if they have to wait for a while, on a properly constructed platform with a light roof over it to protect the churns from direct summer sunshine. Transport rounds will be arranged so that such waiting is minimal. The lorries will leave clean and sterile churns on the platform, and take away the full churns to reach the collecting depot without delay. Here samples of milk will be systematically taken for the determination by quick, modern methods of compositional and keeping quality by a skilled tester working under a centrally organized and controlled milk quality scheme. On his findings fitting payment to the producer will be made. No milk, even that of poorest quality, will be returned to the producer. It will be appropriately salvaged. Slightly better milk which is of insufficient quality for the liquid milk market may be used for other purposes. The satisfactory milk will then either be brine-cooled or, better, pasteurized by the H.T.S.T. process before being sent forward immediately by rail, road, tank or churn to the distributing dairy.

In the very near future the waste of milk due to souring, which last summer reached a magnitude little short of scandalous, must be prevented. Methods for the prevention of souring, even in hot weather, have been thoroughly well worked out and are well known to many, perhaps half our dairy farmers, collecting-depots or creameries, and milk distributors. In the near future, every dairy farmer whose milk consistently fails to reach the necessary standard will be instructed on his farm by the county advisory staff on points of major importance, such as the adequate cleansing and sterilization of farm utensils, milking equipment and churns, and on methods for cooling the milk to below 65° F. and keeping it cool. Hot weather provides in an almost literal sense an acid test of efficient milk production and handling, and the milk industry of the future will be ashamed of its technical inefficiency if souring or taint production continues to occur every time there is a hot spell.

Collecting depots and distributors in trouble will similarly be assisted by the provincial dairy bacteriologist. The producer is by no means always responsible if summer souring occurs. Faulty churn washing, too prolonged transport rounds, or some other factor not within his control may be to blame.

Pasteurization Requirements

The pasteurization bogey which has caused so much controversy and even ill-feeling in the past is now satisfactorily laid. Careful scientific experiment extending over some years has recently shown, and all those competent to assess the clear-cut evidence now agree, that properly controlled commercial pasteurization causes practically no nutritional damage to milk. In the near future it will almost certainly be a national requirement that all milk sold for liquid consumption shall either be effectively pasteurized, or shall be from disease-free animals. The methods of pasteurization which will be used for the majority of town supplies after the War will undoubtedly be the H.T.S.T. process, recently officially accepted, which offers considerable technical advantages besides requiring far less space and metal than the old 'holder' process.

A beneficial consequence of such a national requirement is that many of the dirtier milk-handling and distributing premises will have to shut down. This will save a good deal of the unnecessary and wasteful duplication of milk rounds that still persists even under present war-time conditions. It is quite absurd that in a town of 100,000 inhabitants there should be no fewer than 200 licensed distributors of milk, many of them working from domestic kitchens and back-yards under indescribable conditions. Ten distributing units, adequately staffed and hygienically equipped, could do the job far more satisfactorily. Whether compulsory pasteurization is introduced or not, careful re-inspection of all licensed milk distribution premises is urgently needed in the immediate future, with revocation of licence where ordinary conditions of decency are unattainable.

The milk-distributing, like the milk-producing side of the industry, suffers from having too many small, dirty and inefficient units. It also suffers, even to a greater extent that the milk-producing side, from a paucity—almost a complete absence—of organized technical and vocational training and advisory help. Modern milk distribution is not a robot operation which can be carried out by unintelligent and untrained personnel. One of the pressing needs of the immediate future is the organization of courses of technical training in processing and distribution of milk.

Education and Research

Any long-term view of the future of the milk industry must concern itself with (*a*) the general education, and (*b*) the vocational training of the dairy farmer, the milk distributor and manufacturer, and the housewife. The milk industry is founded on knowledge that is continually advancing and extending, and its future prosperity and ability to meet the demands which the nation will make on it will depend in large part on the rate with which new knowledge can be acquired, assimilated by the industry and effectively applied.

As regards the acquisition of new knowledge, the total number of workers dealing with the research problems of milk production, processing and distribution is very small, probably less than fifty for Great Britain. Compared with the magnitude of the industry, the extent to which it is based on scientific and technical knowledge, and the number and importance of the immediate problems, both fundamental and otherwise, that await solution, this number is almost incredibly small, able though the little handful may be, and until a year or so ago its financial resources were grossly inadequate.

One of the needs of the near future is increased facilities for semi-large-scale experiments, both on milk handling and processing problems, and in methods of milk production, with an adequate research staff to deal with them. (Research workers of the type I have in mind require from five to ten years of post-graduate training before they can tackle such problems adequately, and the training of such workers is in itself a problem which the paucity of dairy research facilities in the past has rendered acute.) At present there are in several cases only two alternatives: either to leave a piece of work at the laboratory stage of development and trust that some better equipped country or some private firm will take it up, or to endeavour to go direct from the laboratory to the full industrial scale through the good will, and at the risk of, a firm in the industry. This latter method, even at the best, inevitably involves lack of control of details, of labour and of management that may make the difference between success and failure.

For experimental work on the improvement of milk production, research facilities are still meagre. Experiments on an adequate scale in dairy husbandry and on the physiology of the dairy cow will need, in the future, the use of several large experimental herds under careful control, if they are to have a prospect of success within a reasonable time.

As regards the dissemination and practical assimilation into agriculture without too great a time-lag of the results of research, the recently founded Agricultural Improvement Council should be, both in the immediate future and after the War, of considerable benefit to the production side of the milk industry, and to a smaller degree to the handling and distributive side. The maintenance of adequate financial support for the activities of the Agricultural Research Council and the Agricultural Improvement Council, after the War, is a vital step towards securing a brighter future for the milk industry.

OPENCAST MINING

By PROF. J. A. S. RITSON, O.B.E.

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DURING recent months the provision of sufficient coal to meet the growing needs in Great Britain of the munition industry, as well as the domestic consumer, has been exercising the minds of the public and has been the subject of considerable discussion in the Press and both Houses of Parliament. Among the many suggestions for increasing the war-time output, the winning of coal by opencast methods has been mentioned. Opencast workings or opencuts are surface excavations in which the overburden is stripped by hand or mechanical excavators, thereby laying bare the mineral, which is afterwards broken and loaded into wagons or lorries by methods similar to those used for removing the overburden. In some localities in Great Britain the conditions are known to be suitable for the successful application of this method of working and intensive prospecting may result in the discovery of more. Several estimates of the total amount of coal available and also of the amount that can be extracted in the current year have been given wide publicity, but the facts, as so far proved, suggest these figures are optimistic.

The coal seams outcrop at the surface in nearly all the coalfields of Great Britain, but in the majority of cases they have already been worked by the 'old men' from bell-mouthed pits or else by gangs of miners during periods of industrial trouble, such as strikes or lockouts.

There is nothing new in the method, which has been practised since the early days of mining, and it is in common use in most parts of the world to-day. The brown coal of Silesia is worked this way, large quantities of bedded ironstone are produced from such operations in Great Britain itself, also ironstone in Austria, the United States and the Gold Coast, tin in Malaya and Nigeria; chrome in Turkey, coal in the United States, Australia and Bulgaria, copper in Chile and the United States. These are typical examples, which can be multiplied many-fold, of successful exploitation of the method.

In Great Britain the application of the method to coal has never before been tried, the reason being that much of the better quality coal close to the surface has already been worked by underground methods, and successful opencasting requires either a large force of cheap labour or the provision of heavy, costly, excavating machinery of various types, many of which have only become available in recent years. Such machinery has been most successfully applied to home ironstone mines where the quantity of ironstone is large and the mining conditions very suitable. The majority of the remaining available excavating plant is in the hands of public works contractors who, while skilled exponents of the art of removing ground, have had little or no experience of the much more difficult problem of selective excavation, which arises when two or more seams of coal are separated by comparatively thin layers of stone. Special machinery is needed to deal with such a problem and it is not usually readily available in Great Britain.

As a coal seam approaches the surface its quality deteriorates. The moisture content is increased and the coal substance oxidized, it becomes dull and friable and loses both its coking and gas-making properties. It resembles in many ways an inferior lignite or brown coal. A typical analysis from one outcrop showing the change in composition of the coal as the cover gets thicker is given below :

Sample	Moisture as obtained or received	Air-dried moisture	Ash	Volatile matter less moisture	Total sulphur	Cal. val. (B.Th.U. per lb.)		Carbon on ash-free dry coal	Hydrogen on ash-free dry coal
						As received	Air-dried coal		
1st strip	31	10·3	6·3	33·4	0·7	7,150	9,350	70·7	3·8
2nd strip	25	6·8	2·8	33·3	0·8	8,690	10,750	72·7	4·0
3rd strip	18	8·5	1·6	31·8	1·1	10,470	11,670	76·4	4·6
Normal seam	—	5·9	3·7	33·3	2·0	—	13,600	82·3	5·3

As a consequence of this deterioration, thorough prospecting of each site by boring or trial holes to prove the quality of the coal and, at the same time the nature of the overburden, should be undertaken before productive operations begin. Failure to undertake this preliminary investigation may result in disaster.

The nature of the overburden is important; it should not be too porous or too hard. Tough clay not containing too many large boulders makes the best top surface, and this should be underlain by an impervious shale which can be broken by the digger without the use of explosives. Harder rocks like massive sandstone may render an otherwise desirable site unworkable. Explosives often have to be used to shake the tougher rocks so that they can be removed by the excavators, but their use adds to the complexity of the operations.

An ideal site involves a horizontal seam of coal with overburden that can be stripped in one operation. Rarely, except in the United States, are these conditions found; certainly not in Great Britain. Here the conditions usually consist of a more or less horizontal seam with a gradually increasing overburden; that is, the seam outcrops on the side of a gently sloping hill or, alternatively, the seam dips away from the outcrop and the surface remains level.

The value of the product determines in peace-time the thickness of overburden that can be removed. With coal the ratio is of the order of 3 or 4 to 1; with ironstone the figure is larger. To-day in England 20–30 ft. of cover are being removed to recover 5 ft. of coal, whereas with ironstone as much as 70 ft. are taken. The general plan of operations consists of combinations of loosening, stripping and transporting of overburden and mineral. The combination selected depends upon the shape, size and depth of excavation, the type of mineral, the quantity and value, output required, the surface topography, the nature and inclination of the overlying strata. Output and method should be adjusted to the total value of the product, so as to secure a minimum cost of production, though this may be qualified in war-time if output is more important than cost.

Stripping may be completed before beginning mining, or stripping and mining may proceed simultaneously when a sufficient area has been uncovered to avoid interference between the two operations. The latter plan is the better as it reduces the initial expenditure before production begins. Stripping may be done in one or more stages, depending on the depth. The overburden must be disposed within reasonable distance to avoid haulage costs and double or treble handling at points where the dumps will not embarrass future operations. The usual procedure is to remove the overburden with mechanical shovels or drag-line excavators and lay it on barren ground behind the outcrop line. Sometimes mechanical scrapers remove the top soil and carry it away, so that when the land is reclaimed after the coal is extracted the top soil can be put back on top.

Frequently large excavators with buckets carrying 12 cu. yards at the end of an 80-ft. boom are used in the main excavation, while smaller 2-yard machines stack the excavated ground clear of the cut. After the overburden has been removed down to the top of the coal, the Americans use mechanically driven rotary brooms to clean off the remaining dirt. Then the coal is dug by small shovels of $\frac{3}{4}$–$1\frac{1}{2}$ cu. yards capacity and loaded on to conveyor belts, wagons, large or small, or into lorries, some of which have a capacity of 10 tons. These take the coal either direct to the consumer or to simple screens where it is graded into two or more sizes.

The first coal obtained, that under the thinnest cover, is usually of poor quality, friable and breaks into small pieces quite suitable for the modern mechanical chain grate boilers, but as the cover thickens the quality improves and the average size of the product increases, so that in order to obtain its full value it has to be graded into large, nuts and slack, each of which has a definite commercial use.

Ironstone workings are usually of a more permanent nature than coal projects; consequently much larger and therefore more efficient plant can be, and is, used. The actual cost of mining ironstone is remarkably low.

The average coal prospect so far exploited in Great Britain contains up to 250,000 tons of coal, its breadth is 60–100 yards and its length $\frac{1}{2}$–$\frac{3}{4}$ mile. The overburden increases from about 12 ft. at the outcrop to 40 ft., giving an average thickness of 25 ft. for a 4–5-ft. seam. One interesting operation is working both flanks of an anticline where there are five seams of coal totalling 30 ft. in all, and these are being pursued to a total depth of 70 ft.

The largest known deposit unfortunately lies under 25–30 ft. of peat in the centre of a low valley, which was once a marsh, and the surface has only recently been drained. The difficulties of dealing with waterlogged peat and water make the proposition at present unattractive. Other outcrops which have not been touched are situated in built-up areas, public parks or allotment gardens.

Many of the outcrops in Great Britain occur under land which is suitable for agricultural purposes and in such cases care has to be taken to disturb as small an area as possible. The top soil is removed first and laid on one side, then the overburden is removed and dumped behind the excavation. After the overburden has had time to settle, it is levelled by mechanical spreaders or 'bull-dozers', field drains are renewed and then the top soil is brought back and the whole re-levelled. Experience has shown that the land, though at a lower level, loses none of its fertility and in two to three years is under cultivation again.

In some instances in Great Britain, and particularly so in America, the overburden is only roughly levelled and then planted with conifers. Flourishing plantations of larch, Scotch fir and spruce can be seen in the ironstone area.

During war-time, land for opencast work can be requisitioned under the Defence Regulations and this is usually the simplest method to employ. But various questions of compensation have to be settled. The coal owner must be paid for the coal extracted from under his land and the purchase price is generally on a tonnage basis; the colliery company that has leased the right to work the coal from its owner wants compensation for loss of rights or potential profit; the surface owner, if the land is divorced from the mineral beneath, requires compensation for damage to his land, loss of rent and amenities, while the farmer is denied, for the time being, the opportunity of cultivating the area in question.

Another point that has to be settled is transport. In some instances the coal can be loaded into lorries and carried direct to the consumer, but in most cases the railway or canal has to be utilized. This means the provision of new sidings or loading stages or, alternatively, the adaptation of existing sidings to outside traffic.

In peace-time the practice will not offer any financial attraction to operators, but in war-time, when it is essential to produce every ton of coal, it is worth pursuing.

IS MUSCLE CONTRACTION ESSENTIALLY AN ENZYME-SUBSTRATE COMBINATION?

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ABOUT twelve months ago an account was given in NATURE of the striking action of adenylpyrophosphate upon the flow-birefringence and viscous properties of the globulin of muscle, myosin[1]. Since the dephosphorylation of adenylpyrophosphate is believed to be the immediate source of energy for contraction, and since, in the most recent work, it has proved impossible, in spite of serious efforts, to separate adenylpyrophosphatase activity from the protein myosin (Bailey[2], Needham[3], confirming the original work of Engelhardt and Ljubimova[4]), a continuation of this work seemed necessary. Having in the meantime made further progress in the study of the physico-chemical relations of adenylpyrophosphate and myosin, we desire to make the following further interim report.

The apparatus used was partly described in the previous note. It now consists of a small annular cell with rotating external cylinder, mounted on the stage of a polarizing microscope; and a co-axial viscosimeter with glass bottom permitting optical measurements of flow-birefringence. Three variables are observed: (*a*) the intensity of flow-birefringence itself; (*b*) the extent of the anomalous viscosity (that is, the fall of viscosity at low shear-rates); and (*c*) the relative viscosity, that is, the constant level to which the viscosity eventually falls as the shear-rate increases. The flow-birefringence and the anomalous viscosity of myosin solutions are, of course, taken to indicate that the particles are of considerable length.

Since the data in the literature on the physico-chemical properties of myosin, though numerous, are rather disjointed, we had to devote a good deal of time to the systematic examination of certain effects, as background for the interpretation of the action of adenylpyrophosphate on myosin. Thus we find that in passing from member to member of the Hofmeister series of cations at $0\cdot5M$ ($\mathrm{Li}^{\cdot}$, $\mathrm{Na}^{\cdot}$, $\mathrm{K}^{\cdot}$, $\mathrm{Rb}^{\cdot}$ and $\mathrm{Cs}^{\cdot}$), there is no change in the flow-birefringence (hereinafter written $\triangle$), and only slight effects on the relative viscosity (η). $\mathrm{NH}_4^{\cdot}$, however, decreases $\triangle$. The behaviour of these properties as a function of different salt molarities is very similar for $\mathrm{K}^{\cdot}$ and $\mathrm{Li}^{\cdot}$; $\triangle$ falls (for example, from $\triangle$ 60° at $0\cdot5M$ to $\triangle$ 20° at $3\cdot5M$); while η first falls to about $1\cdot0M$, and then rises. (A hump is often observed at salt concentrations varying between $0\cdot5$ and $1\cdot5M$, which explains certain results mentioned in the previous note, but requires further study on more purified preparations.) At the higher salt concentrations corresponding to the rising limb of the curve, the flow anomaly appears to be lost. The whole picture may therefore be interpreted either as one of progressive disaggregation, or the formation of larger, unoriented, tangles; the process ending in precipitation by salting-out. With divalent cations, such as $\mathrm{Ca}^{\cdot\cdot}$ and $\mathrm{Mg}^{\cdot\cdot}$, though the flow-birefringence ($\triangle$) falls steadily as their concentration rises up to $0\cdot5M$, the relative viscosity (η) on the contrary *rises*, continuously in the case of $\mathrm{Ca}^{\cdot\cdot}$, but reaching a maximum about $0{\cdot}1M$ and then declining in that of $Mg^{\cdot\cdot}$ (see Fig. 1 *a*).

In the Hofmeister series of anions at $0{\cdot}5M$, though SO_4'', Cl' and Br' have no effect either on Δ or η; I' and SCN' reduce Δ and exert extensive and complex effects on η.

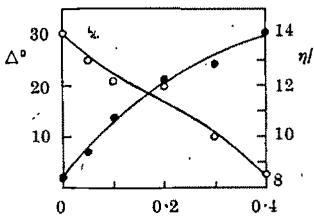


Fig. 1*a*.

The behaviour of myosin's Δ and η at different *p*H is interesting. Just above *p*H 5·5, as the protein comes into solution above its iso-electric point, both flow-birefringence and relative viscosity decline from high values to a constant level reached about *p*H 6·3, and this constant level is then maintained until *p*H 9·0, at which point the two properties begin to diverge. Flow-birefringence falls off to reach zero about *p*H 11·0 and relative viscosity climbs to values as high as they were just above the iso-electric point (see Fig. 1 *b*). Falling birefringence with loss of anomaly and rising relative viscosity may be interpreted as disaggregation or tangle-formation perhaps accompanied by hydration.

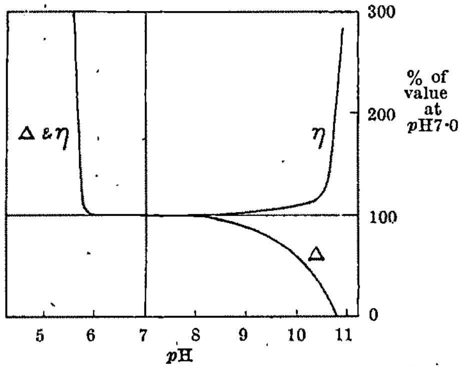


Fig. 1*b*.

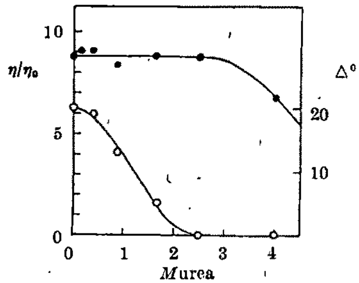


Fig. 1*c*.

Finally, with urea, in increasing concentrations up to 7 or 8 *M*, the relative viscosity, as shown by Edsall and Mehl[5], falls off to low levels. But during the range over which the flow-birefringence is falling to zero, the relative viscosity remains constant, that is, up to about $2{\cdot}5M$ (see Fig. 1 *c*).

The conception generally prevailing (see Edsall[6]), that decreases in flow-birefringence of myosin are irreversible and imply denaturation, must now be abandoned. After the action of adenylpyrophosphate, Δ invariably returns to its initial value; and if samples of myosin the flow-birefringence of which has been reduced by various agents are reprecipitated, the protein is found to be soluble, and the birefringence to have been largely restored. We may cite the following figures:

	Δ in % of control	Δ in % of control after reprecipitation and re-solution
$0{\cdot}5M$ LiCl	100	100
$0{\cdot}03M$ adenylpyrophosphate	50	74
$0{\cdot}1M$ $MgCl_2$	39	70
$0{\cdot}1M$ urea	30	100
$1{\cdot}0M$ urea	17	74
$2{\cdot}0M$ urea	10	65

After $6{\cdot}0M$ urea, however, neither solubility nor flow-birefringence are regained. There are, moreover, the restorations of flow-birefringence by treatment at 37°C., described in the previous paper, but further experience (which will be described elsewhere) leads us to think that they are rather different from the adenylpyrophosphate effect at or below 20°C.

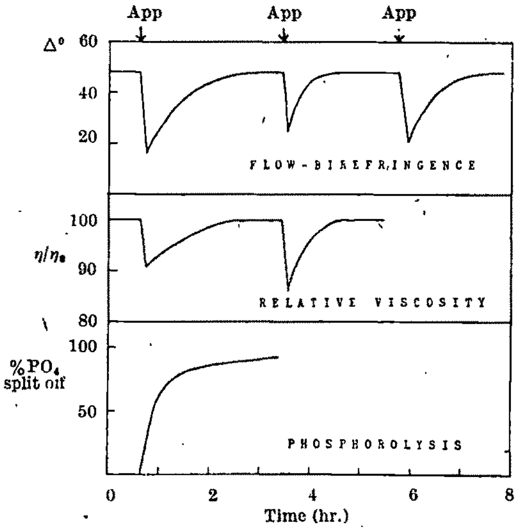


Fig. 2.

How do the effects described above compare with that produced by adenylpyrophosphate (prepared mostly by the classical method, but sometimes by that of Kerr and Seraidarian[7], which gives a purer product, freed from iron) upon myosin? When a myosin sol is treated with adenylpyrophosphate at concentrations as low as $0{\cdot}004M$, the flow-birefringence (Δ) is reduced by some 40–60 per cent, the anomaly is unaffected, and the relative viscosity (η) is reduced by some 20 per cent. The subsequent return of both Δ and η to their original values, which may take from a quarter of an hour to several hours, according to the conditions, is accompanied by the splitting off of inorganic phosphate from the adenylpyrophosphate. The fall of Δ and η is quite repeatable on the same sample of myosin—Fig. 2 shows an experiment in which three successive falls and returns of Δ were observed, two successive falls and returns of η, and over the first period the splitting off of inorganic phosphate was exactly measured. The question immediately arises whether we have to deal here with a true contractility of the myosin particles. Since the anomaly is retained, the particles must continue to be rod-like, but since the flow-birefringence is reduced, their axial ratio must be less than before. The decrease in relative viscosity would then be expected, as we know from work on polymers (see, for example, Kraemer and van Natta[8]; Powell and Eyring[9]) that η is proportional to polymer length at equal molar concentrations. But at the same time, in the absence of some sort of determination of the number of particles present, changes of aggregation and of hydration are also possible. But even were the phenomenon wholly one of disaggregation rather than true contraction, the physiological significance of the effect might be none the less.

As regards stoichiometric relations, varying the concentration of adenylpyrophosphate at 20°C. and neutral *p*H, shows that for a sol of 0·86 per cent protein approximately the full effect is obtained at $0\cdot004\ M$, falling off very rapidly at lower concentrations, and being very little higher at amounts up to $0\cdot2M$. It should be emphasized that this concentration is much lower than that of any of the other classes of substances which affect myosin's flow-birefringence. To produce a 60 per cent fall of $\triangle$, $1\cdot5M$ urea is required, $1\cdot0M$ monovalent cation, and $0\cdot2M$ divalent cation; or a *p*H of 10. From the dosage data a tentative calculation can be attempted, adopting the figures of Astbury and Bell[10], including a molecular weight of 67,000 for myosin, that thirty molecules of adenylpyrophosphate are required for every molecule of myosin, or one for every nineteen amino acids in the myosin chain. Whether the fact that phenylalanine and methionine occur sixteen times in the repeat unit, and tyrosine eighteen times, may have any significance in this connexion remains to be determined. But the possibility immediately arises that adenylpyrophosphate, the actual energy-providing substrate of the contractile protein itself, may in fact be the agent of contraction, which it would bring about by its initial combination with the enzyme.

One might perhaps picture the molecular length of adenylpyrophosphate being shorter than the length between the groups on the myosin chain to which it becomes attached, so that a contraction must accompany combination. This would be in line with the general two-affinity theory of enzyme action, only in globular proteins configurational changes in the enzyme protein would not be so readily observable as in linear proteins.

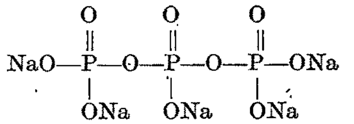
The evidence for the identity of myosin and adenylpyrophosphatase, resting upon the failure of all attempts to separate them, must remain of a negative character. But the fact that far-reaching optically observable changes in the myosin accompany the enzyme-substrate combination and the enzyme action, gives positive support to the view that the enzyme is myosin itself. It may therefore now be allowable to speak of a 'contractile enzyme'.

We should like to emphasize at this point that the viscosity data themselves suggested a specificity in the action of adenylpyrophosphate on myosin. With cations and at alkaline *p*H ranges $\triangle$ falls while η rises; with urea $\triangle$ falls while η remains constant; only with adenylpyrophosphate do $\triangle$ and η fall together to a limited and well-defined extent, which larger doses will not increase, and which is spontaneously reversed during the subsequent enzyme action. It therefore seemed important to explore more thoroughly the action of other substances which might have the same effect as adenylpyrophosphate. The following were tested at $0\cdot03M$ with quite negative results: lactate, glucose, glucose-1-phosphate (Cori ester), hexose-6-phosphate (Embden ester), hexose-diphosphate (Neuberg ester), glycerophosphate, phospho-glycerate, creatine-phosphate, adenylic acid, inosinic acid, aneurin, aneurin-pyrophosphate (co-carboxylase), diphenyl-pyrophosphate (Neuberg and Wagner[11]), inorganic pyrophosphate, metaphosphate, hexametaphosphate.

Any substances, of similar constitution to the substrate, and which combined with the enzyme, might be expected to show some degree of competitive inhibition. They would block the fall of $\triangle$ produced by adenylpyrophosphate, and inhibit the subsequent enzyme action.

The following substances were tested, and gave no such effects: inorganic orthophosphate, pyrophosphate, metaphosphate, hexametaphosphate, diphenylpyrophosphate, adenylic acid, inosinic acid.

We were able to observe the adenylpyrophosphate effect, however, using adenosine-diphosphate (prepared according to the method of Ljubimova and Pevsner[12]), but only on relatively unpurified myosin preparations. Thrice-precipitated myosin is not affected by adenosine-diphosphate, probably because the 'myokinase' of Kalckar[13], which converts it partly into adenylpyrophosphate, is removed by this purification. The adenylpyrophosphate effect is also fully given, even on thrice-precipitated myosin, by inosinic-(inosine-triphosphate)-pyrophosphate, where the amino group on the purine ring has given place to a keto-group (prepared by the method of Lohmann[14], and purified according to Kiessling[15]). An interesting result is obtained with inorganic triphosphate (prepared according to the method of Huber[16]):



$$\begin{array}{ccccccccc} & \mathrm{O} & & & \mathrm{O} & & & \mathrm{O} & \\ & \| & & & \| & & & \| & \\ \mathrm{NaO}- & \mathrm{P} & - & \mathrm{O}- & \mathrm{P} & -\mathrm{O}- & & \mathrm{P} & -\mathrm{ONa} \\ & | & & & | & & & | & \\ & \mathrm{ONa} & & & \mathrm{ONa} & & & \mathrm{ONa} & \end{array}$$

which, as Neuberg and Fischer[17] showed, is hydrolysed by muscle extract. This substance is split by the enzyme, giving inorganic phosphate, and as in the case of adenylpyrophosphate and inosine-pyrophosphate the process is accelerated by $Ca^{\cdot\cdot}$, but it has no effect whatever on the flow-birefringence. Correspondingly, it does exert a certain degree of competitive inhibition on the adenylpyrophosphate reaction, diminishing (in a typical experiment) the birefringence-reduction to 63 per cent of the control, and the phosphorolysis to 46 per cent of the control.

It would appear, therefore, to be highly probable that myosin is a specific triphosphatase. Since triphosphate combines with the protein and is split without causing any fall of $\triangle$, we may say with some plausibility that the purine-ribose end of the adenylpyrophosphate molecule is also of great importance in changing the shape of the protein molecule.

The only other attempt which has been made to elucidate the relationships of adenylpyrophosphate and myosin, which to-day seem crucial for any fundamental understanding of protein contractility, is that of Engelhardt, Ljubimova and Meitina[18]. Partially dried fibres of myosin, prepared by injection from extruders into distilled water, and still retaining some adenylpyrophosphatase activity, were treated with a variety of substances, of which alone adenylpyrophosphate showed any effect—an increase of extensibility. The concentration of adenylpyrophosphate used was similar to that found by us to be minimal for complete effectivity, that is, $0\cdot0025M$.
]

It is, of course, impossible to compare readily the results of two techniques so different, especially as the full details of the Russian work are not yet available.

In conclusion, it seems now fair to say that the interaction between adenylpyrophosphatase and its natural substrate brings about deep-seated and optically observable effects upon the enzyme's physical state. Whether these changes are micellar in character, or whether they are analogous to the configurational changes established for the keratins, remains as yet uncertain. Could adenylpyrophosphate itself then be normally *in vivo* the agent of contraction? Were this so, the reception of the nervous or other stimulus would essentially allow the enzyme and substrate to come in contact. By this enzyme-substrate combination the configuration of the contractile enzyme would itself immediately be changed (as pictured by Astbury and Dickinson[19]; Astbury[20]), and the later splitting off of inorganic phosphate from the substrate would supply the energy needed for the relaxation and recharging of the myosin fibril. The solution of these problems will be of much importance, not only for muscle physiology, but also for many other fields of biology into which fibre-properties enter, such as morphology and morphogenesis (cf. the recent work of Pollister[21] and Hobson[22]).

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The work would scarcely have been possible without a grant-in-aid from the Rockefeller Foundation, which supports two of us (A. K. and M. M.), and for which we are deeply grateful.

OBITUARIES

Prof. A. R. Forsyth, F.R.S.

PROF. ANDREW RUSSELL FORSYTH, emeritus professor of the Imperial College of Science and Technology, South Kensington, died on June 2 at Bailey's Hotel, London, where he had lived since he retired in 1923 from his position as chief professor of mathematics at the Imperial College. His age just fell short of eighty-four, as he was born (at Glasgow) on June 18, 1858.

He was educated at Liverpool College and at Trinity College, Cambridge. His student career at Cambridge was brilliant: he was Senior Wrangler, and First Smith's Prizeman in 1881, in which year also he was elected to a prize fellowship at Trinity. In the following year he became professor of mathematics at University College, Liverpool, but two years later, in 1884, he returned to Cambridge as a lecturer of his college and of the University. In 1895 he became Sadleirian professor of pure mathematics at Cambridge in succession to Cayley, whose voluminous collected papers he edited (1895–98).

While still in his twenties Forsyth attained a reputation as a pure mathematician that extended far beyond the borders of his own university and country. His distinguished researches, an account of which is given separately below, led to his election as a fellow of the Royal Society at the early age of twenty-seven, and eleven years later he was awarded a Royal Medal of the Society. In the same year he was president of Section A of the British Association at its Toronto meeting, a distinction which he held a second time in South Africa in 1905. He was president of the London Mathematical Society during 1904–6.

Besides making important original contributions to pure mathematics, Forsyth rendered a service of special value to his university in breaking the bonds of the isolation of its mathematical school, during the latter part of the nineteenth century, from the great Continental movements of thought in the subject. By his writings and his lectures he widened the knowledge and outlook of his colleagues and students, and stimulated a revival of pure mathematical learning and research in England.

Forsyth was a prolific author of books, beginning in 1885 with a text-book on differential equations, that has run through many editions, and has been translated into several languages; this was followed by a large treatise on the theory of differential equations, in several volumes (1890–1906), and by an attractive text-book on the theory of functions (first edition in 1893).

During his Cambridge period he found time also to take part in the government of the University, as a member of the Senate during 1890–1910; and in other public work, for example, as a member of the Treasury Committee on the Scottish Universities, in 1909.

For many years Forsyth was regarded abroad as the leader and representative of English pure mathematics, and honours from universities and academies the world over were bestowed upon him. He maintained many personal and official international contacts; he travelled much and was an accomplished linguist.

In the midst of his fame he left Cambridge (1910), resigning his chair and the college fellowship that meant so much to him. In painful circumstances he made a marriage of affection, and gained ten years of a happiness for which he counted the loss of many old associations a price not too high. For a time he was without any official position, and during this period he delivered in Calcutta (1913) a series of lectures on differential geometry (afterwards published as a book).

Forsyth entered on the last phase of his teaching career when in 1913 he accepted the headship of the department of mathematics at the Imperial College, combining the direction of two previously separate schools (one in the Royal College of Science, the other in the City and Guilds Engineering College) headed by Profs. Perry and Henrici, who retired nearly at the same time. The War of 1914–18, and its aftermath, interrupted his plans for building up a new honours school of mathematics at South Kensington, and he retired from his chair in 1923, after ten years tenure, on attaining the age limit of sixty-five.

His wife had died of cancer not long before, to his intense grief; he cherished her memory most tenderly, and in his will he left his residuary estate to the Royal Society for cancer research.

In his lonely retirement Forsyth found solace in his mathematical studies, and published two further treatises, on the calculus of variations (1927) and the geometry of four dimensions (1930); he also continued his linguistic studies.

His last years were clouded by frequent illness. His thoughts dwelt much on his Cambridge days, particularly on the old-time Tripos conditions of his student period, and on the Senior Wranglers of those years. In his last illness his mind lived in this golden epoch of his youth. S. CHAPMAN.

THE old Tripos admitted of very little specialization, and a Senior Wrangler was bound to have a competent knowledge of every branch of mathematical science known to the Cambridge of his day. The emphasis was generally on mathematical physics, in which England led the world; and Forsyth's first original paper—written when he was still an undergraduate—was on the motion of a viscous incompressible fluid. Immediately after taking his degree, he began to work on a fellowship dissertation; for some time he toyed with the kinetic theory of gases, but finding this unprofitable, he turned to an idea which had occurred to him when listening to Glaisher's advanced course on elliptic functions, and in two months produced the great memoir on the double theta functions, which occupies 79 pages of the *Phil. Trans.*, **173**, and which, besides winning the fellowship, laid the foundation of his fame as an original investigator.

The subject was well suited for the display of Forsyth's most characteristic gifts: a masterly algebraical technique in dealing with vast numbers of symbols, and a wonderful power of detecting identities and relations in problems of great complexity. In the following year he wrote a long and valuable paper on a closely related subject, Abel's theorem and Abelian functions, which was printed in *Phil. Trans.*, **174**, and after this a substantial work on the Weierstrassian doubly periodic functions (*Quart. J. Math. Soc.*, **22**), which he introduced to Cambridge mathematicians (Glaisher always adhered to the Jacobian *sn, cn, dn*). It is somewhat remarkable that although a pupil and fervent admirer of Cayley, he had up to this time done nothing on Cayley's great subject, the invariant-theory of algebraic forms; and when he did come to it, in 1887, it was not directly but by the roundabout way of differential equations. In a single year, 1889, he published five papers, totalling 284 pages, on the concomitants of algebraic and differential forms; and in the next year, more than a hundred pages in the *American Journal of Mathematics* on a topic in the same field, "Systems of ternariants that are algebraically complete".

The following years were spent chiefly in preparing himself for writing a book which had perhaps a greater influence on English mathematics than any work since Newton's "Principia", namely, the "Theory of Functions of a Complex Variable", which was published in 1893. This for the first time opened to his countrymen the vast development of pure mathematics which had taken place on the Continent in the nineteenth century; it broke the Cayley tradition, and led all the younger generation at Cambridge into the new domain. On Forsyth's part it was a patriotic and self-sacrificing action; for while the fresh impetus brought vigour and fame to the school, the situation was not well suited for the exercise of his special aptitudes: there was little opportunity of superb generalship with symbols, and his somewhat unphilosophical mind was at a disadvantage when confronted with the new type of problems. Moreover, by turning everyone's attention away from the subjects in which his greatest triumphs had been won, he caused what was in effect a lowering of his own popular reputation.

Another factor which perhaps likewise tended in some degree to displace Forsyth from the supreme position which he held in the general estimation at the end of the nineteenth century was the practice, which he adopted from this time onwards, of publishing most of his discoveries, not as they were made, in separate papers, but in advanced treatises (some of them of colossal size), each summing up the work of several years. Human nature being what it is, a worker on the remotest frontier of pure mathematics would probably be well advised to impart his results to the world by instalments smaller than those customary with Forsyth; few people are willing to tackle what is practically a continuous heavily analytical original memoir of eight hundred pages. But whatever may be thought of the practical wisdom of his later policy, the great memoirs of his earlier period will secure for him permanently one of the high places in the mathematical pantheon.

E. T. WHITTAKER.

Mr. W. A. Benton

WE regret to record the sudden death of William Alfred Benton at his home at Handsworth, Birmingham, on June 19, at the age of seventy-one. For many years Mr. Benton was in charge of research at Messrs. W. and T. Avery Ltd., Soho Foundry, Birmingham, and was a well-known figure in scientific circles. He was a fellow of the Physical Society and a past president of the Birmingham Metallurgical Society; among other activities he was a member of the Society of Chemical Industry, the Newcomen Society and the Wolverhampton and District Society. During the past few years Mr. Benton had been compiling a work on the history of the balance, and it is fortunate that the greater part has already been completed.

Outside his professional interests, Mr. Benton was a keen amateur photographer, and was a member of the Royal Photographic Society and local photographic societies.

WE regret to announce the following deaths:

Mrs. F. Rhys Davids, president and co-founder of the Pali Text Society, on June 26, aged eighty-four.

Lord Glanely, president of the University College of South Wales and Monmouthshire, at Cardiff, on June 28, aged seventy-four.

Sir Daniel Hall, K.C.B., F.R.S., formerly director of the John Innes Horticultural Institution, and for some years chief scientific adviser to the Ministry of Agriculture, on July 5, aged seventy-eight.

NEWS and VIEWS

Colonial Research Committee

THE Right Hon. Viscount Cranborne, Secretary of State for the Colonies, was present at the inaugural meeting of the Colonial Research Committee held on June 29, and defined the scope and purpose of the Committee's work (see NATURE, July 4, p. 17). He said that the Committee will have two functions. In the first place it is to advise the Secretary for the Colonies on schemes for assistance from the £500,000 a year which is provided under the Colonial Development and Welfare Act for "research and inquiry". But this is only part of a wider function; what is needed is a broad survey of the whole range of research in Colonial studies. We need to know, first, what subjects ought to be studied, secondly, what is being done now, and thirdly, what can and should be done to fill the gaps. In several respects the field is not at present adequately covered. The older sciences have in this respect the advantage; but there are newer sciences, the application of which to Colonial questions has not at present gone very far. Many of these could render work of immediate practical value to the Colonial Empire.

Lord Cranborne then emphasized that the Committee should undertake "inquiries". There will undoubtedly be many applications, he said, from Colonial Governments for assistance in making inquiries that will be of immediate practical value to them—jobbing inquiries that the pure scientist may rather scorn to describe as research proper. The Government's intention, however, is that the Committee should include all forms of inquiry in its field—the ascertainment, collection and assessment of all facts that may be of value to the Colonial Empire. This is not to be interpreted, however, as limiting investigations to research of immediate application to Colonial problems. In attempting to define "Colonial studies", Lord Cranborne pointed out that while there is little that is common to all parts of the Colonial Empire, there are some things that are common to large parts of it. For example, most of the Colonies are in the tropics, they are engaged in primary production, in agriculture rather than in industry. Most of them are maritime, and many parts of them are inhabited by peoples who have only recently come into contact with Western civilization. Hence questions relating to tropical health, agriculture and engineering, fisheries and all questions relating to the development of peoples in contact with more advanced civilizations are of interest to the Colonial Empire and thus to the new Committee. Finally, there are large groupings of the Colonies geographically. There are, for example, many Colonies in Africa; all scientific questions relating to Africa, and particularly to tropical Africa, would therefore come within its range of activities.

The Committee, said Lord Cranborne, will inevitably have contacts with many others, outside the Colonial Empire itself, working on problems which are yet of interest to the Colonies. Apart from institutions in Great Britain, there are many in India and the Dominions, particularly perhaps South Africa, and many too in various foreign countries. The other Colonial Powers, for example, all have research institutions, which in happier days after the War will exist again. We share many problems and can share too in their solution—the control of locusts, tse-tse fly research, nutrition and so on. With the United States too we have already a long and happy tradition of collaboration on research matters. Scientific problems do not recognize national boundaries; they will assuredly provide, in the future as in the past, a fruitful field of international co-operation. Lord Cranborne also expressed the hope that the Committee will make it one of its objects to develop research work actually in the Colonial Empire itself. There has been in the last twenty years or so a rapid development of the educational institutions in the Colonies. The addition to such institutions of research workers, engaged primarily in the pursuit of pure knowledge without too close a concern with its practical application, is of great value in fostering an atmosphere of true learning.

Nutritive Value of Meals in 'British Restaurants'

THE feeding of the people of Great Britain during the War is based on scientific knowledge, a great proportion of which has been gained during the last twenty-five years. In the War of 1914–18 sufficient was known about calories, protein and perhaps vitamin C to ensure that these factors were taken into consideration in the choice of food supplies. Disaster, however, might well have overtaken us through ignorance then of requirements of vitamin A. Those who advise the Ministry of Food to-day must therefore use what information they can acquire to ensure, in this War, that no deficiencies of, say, pantothenic acid, vitamin B_6 or biotin affect the national health.

Meals served in British Restaurants represent in many cases a substantial part of the diet of those eating them, and an investigation of the nutritive value of the food actually served on the plates is calculated to give information of great importance. To get such information the Ministry has enlisted the co-operation of a number of scientific workers in universities, hospital laboratories and elsewhere. Each of these workers has taken the responsibility of overseeing each month the type of meal served in his area. In addition, each will analyse the meals for vitamin C at least and, where laboratories have the facilities, investigations of less well-known vitamin factors, analyses of protein or the experimental determination of calorific values will also be undertaken. As the War continues and food supplies become more restricted, it is against unexpected deficiencies that we must guard. Thus the workers who are voluntarily giving their skill and knowledge to the Ministry of Food will be making a real contribution to the national effort.

Medal Awards of the Royal Society of Arts

THE Albert Medal of the Royal Society of Arts for 1942 has been awarded to General J. C. Smuts, Prime Minister and Minister of External Affairs of the Union of South Africa. In deference to General Smuts's well-known preference for brevity and simplicity the following words will be inscribed on the medal: "Statesman. Soldier. Scientist. Philosopher".

Silver medals have been awarded for the following papers read before the Society during the past session: *Papers read at Ordinary Meetings*:—Mr. J. C. Dawes, "Making Use of Waste Products"; Prof. H. D. Kay, "The Future of the Milk Industry"; Mr. James Kewley, "Evolution in the Petroleum Industry"; Mr. E. M. Rich, "Technical Education". *Papers read before the India and Burma Section*:—Sir Bernard Darley, "The Development of Irrigation in India"; Mr. A. J. Gibson, "The Story of Lac"; Dewan Bahadur S. E. Runganadhan, "The Work of Indian Universities". *Paper read before the Dominions and Colonies Section:* Dr. Maurice Ashby, "British Empire Drug Production". *Endowed Lecture:* The Right Hon. Viscount Bennett, "Empire Relations".

American Chemical Society Prize in Pure Chemistry

THE American Chemical Society Prize in pure chemistry of 1,000 dollars has been awarded for 1942 to Dr. John Lawrence Oncley, associate in physical chemistry at the Harvard Medical School and instructor in chemistry at the Massachusetts Institute of Technology. This Prize is given annually for "outstanding research in pure chemistry by a man or woman less than thirty-six years old". Dr. Oncley has made important contributions to protein chemistry, and he has investigated the dielectric properties of gases, insulating oils, resins, rubbers and proteins, developing radio-frequency bridge methods suitable for precise dielectric constant determinations with proteins. With the aid of these methods he completed the first satisfactory study of the dielectric dispersion behaviour of water-soluble proteins. This work constitutes one of the significant contributions of recent years to protein chemistry and has led to further studies on the molecular size and shape of protein molecules.

Award of the Dr. W. S. Bruce Memorial Prize

THE joint committee consisting of representatives from the Royal Society of Edinburgh, the Royal Physical Society and the Royal Scottish Geographical Society has awarded the Bruce Prize to Dr. G. C. L. Bertram for valuable biological work in the Arctic and Antarctic during 1932–37; and especially for his work as biologist with the Graham Land Expedition during 1934–37, when he took part in the important sledging journey which discovered King George VI Sound. His particular work was on seals, and he has written an important memoir entitled "The Biology of the Weddell and Crabeater Seals", published by the British Museum (Natural History) in September 1940 in the British Graham Land Expedition Reports. In addition, Dr. Bertram is the author of a more popular book on the technique of polar travel entitled "Arctic and Antarctic".

Bicentenary of Abraham Sharp

ON July 15, 1742, the mathematician and astronomer Abraham Sharp died at his birth-place, Little Horton, near Bradford, Yorks., at the age of ninety-one, having in various ways furthered the interests of British astronomy. After serving an apprenticeship to a merchant at Manchester, he opened a school at Liverpool, where Flamsteed met him. The meeting led to Sharp joining Flamsteed in the newly erected Royal Observatory at Greenwich where he worked from 1676 until 1690. In 1688 Sharp was given the task of constructing a mural quadrant of 79 in. radius, and this proved to be the most satisfactory instrument Flamsteed possessed. With his other instruments it was removed from Greenwich by his executors after Flamsteed's death, but some eighty years ago parts of a similar instrument by Sharp were given to the Observatory by the Rev. N. S. Heineken. On leaving Greenwich, Sharp settled at Little Horton, calculating, making instruments and corresponding with scientific men. He supplied Flamsteed with observations, and with Crosthwait, Flamsteed's last assistant, he had a share in the publication of the "Historia Cœlestis Britannica", which appeared in 1725, six years after Flamsteed died. In a letter written in January 1722 Crosthwait wrote to his collaborator that "the memory of the ingenuous and disinterested Mr. Sharp will always, by me, be had in the greatest esteem, next to that of my deceased and good friend Mr Flamsteed".

Dr. Charles B. Dudley, 1842–1909

EACH year, the American Society for Testing Materials awards a medal for some outstanding contribution to research in engineering materials, and to commemorate the eminent services of the Society's first president, Dr. Charles B. Dudley, who was born on July 14, 1842. Brought up in Chenango County New York, Dudley at the age of twenty enlisted in the 114th New York Volunteers, fought in a number of battles during the Civil War, and was severely wounded. In 1865 he was free to resume his interrupted studies, and during the next nine years worked at the Oxford Academy, Chenango Co., Yale College and the Sheffield Scientific School of Yale College. Part of his time was spent on newspaper work to provide him with necessary funds. On leaving Yale in 1874 with the degree of Ph.D., he devoted a short time to teaching chemistry and physics at the University of Pennsylvania and at a Military Academy at Poughkeepsie; and then in 1875 became chemist to the Pennsylvania Railroad Company, with headquarters at Altoona, Pa., where he installed laboratories. Much of his work was of a pioneering character and it gradually spread to investigations on all the materials used in the building and working of a railway, from the laying of the track to the ventilation of carriages. Especially important were his researches on rails. Besides being the founder-president of the American Society for Testing Materials, he served as president of the American Chemical Society and at the Copenhagen Congress of the International Association for Testing Materials held in 1909 he was chosen president for the ensuing three years. Soon after his election, however, he died unexpectedly on December 21, at the age of sixty-seven.

30-kw. Short-Wave Radio Transmitter

AN article by F. D. Webster and R. E. Downing (*Elec. Comm.*, 20, No. 3, 1942) describes a new equipment built for All America Cables and Radio Inc. for use in the expansion of its international service at Lima, Peru. The equipment is capable of operating on any frequency between 5·7 mc. and 22 mc., with crystal control or with self-excitation, for carrier wave or modulated carrier wave telegraphy or by means of a separate modulator for telephone or broadcast, to deliver 1 kw. or 30 kw. of radio frequency power on telegraphy or 9 kw. on telephony or broadcast, and of delivering its rated output at any frequency between 5·7 mc. and 22 mc. into a balanced transmission line of 600 ohms surge impedance with any standing wave ratio up to 2 to 1.

Flexibility is achieved by constructing the equipment in four mechanically separate units and by the provision of controls which permit rapid and convenient transfer to any type of operation. The four units comprise a radio frequency driver, a power amplifier, a 3,000-volt rectifier and a 10,000-volt rectifier. For telephone operation two more units are required, namely, a speech amplifier and a modulator. Voltage breakdown, which is an ever-present hazard due to the high voltages produced in radio equipment of this power, is minimized by adequately spacing and insulating all components, by avoiding sharp edges on metal parts, and by installing corona shields and horn gaps where applicable. Excessive temperatures are avoided by employing adequate current-carrying capacity in all conductors, ample radiating surfaces, water cooling, and forced air circulation by means of blowers.

Recent developments incorporated in this equipment include electronic keying with weight control, modulated carrier wave telegraphy by phase modulation, special type balancing network, multistrand filament tube, vacuum condensers. The article gives, at some length, details of the electrical design and the mechanical construction of the general assembly of the equipment and of the component parts which come broadly under the headings of controls, personnel protection, radio frequency driver unit, power amplifier unit, 3,000-volt rectifier unit and 10,000-volt rectifier unit. A table of specifications summarizes the more detailed equipment description.

Optics Applied to Engineering

A LECTURE entitled "Optics Applied to Engineering" was delivered by Mr. K. J. Habell at a meeting of the Leicester Branch of the Association of Scientific Workers held on June 2 at the College of Technology, Leicester. Mr. Habell described the principles of several types of optical instruments now in increasing use in engineering workshops, and much interest was shown in those of the more difficult types of profile projection. The application of telecentric systems for the avoidance of magnification errors due to incorrect focusing and to ensure the imagery of the correct profile was very well illustrated by diagrammatic and experimental slides showing the images of a circular hole produced by convergent, divergent and collimated beams of light. Other instruments described included the tool-room microscope for the examination of form tools and screw-thread forms, and alignment telescopes for measuring the alignment and relative tilt of closely or widely separated bearings and jigs. Details were given of auto-collimating telescopes for high precision work in angular measurement. The importance to the war effort of instruments of the types described was emphasized. A selection of the instruments was on view, and was demonstrated after the meeting.

Chemical Engineering at Leeds

THE Department of Coal Gas and Fuel Industries (with Metallurgy) of the University of Leeds was established in 1906 to provide degree courses in fuel and metallurgy. In 1910 a fund was raised by the gas industry in order to perpetuate the memory of Sir George Livesey, the distinguished gas engineer, and this was allocated to endow the chair of the Department now known as the Livesey professorship. A degree course in gas engineering was instituted at that time. Since then the Livesey Advisory Committee, which is composed of representatives of the Institution of Gas Engineers, of the Society of British Gas Industries, and of the University, has had under consideration the need for extending the courses in order to keep pace with the growth of knowledge and the increasing demands of industry. In particular, for those passing into the constructional side of the gas industry and into the larger undertakings as well as to the staffs of chemical plant manufacturers generally, a broader training is necessary. On this account the Committee recently recommended the establishment of an alternative four-year course in chemical engineering, which has now been approved by the University; the new course will begin with the autumn term.

Domestic Electricity Supply

AN optional-control system of domestic electricity supply is described by P. Schiller (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 9; June, 1942), which is designed to meet the objection often raised to domestic load control of any kind, in that it involves encroachment on the consumer's liberty to use his supply as he wishes. It is suggested in the paper that the consumer be given the opportunity at any moment and for any period of time readily to change over from a controlled to an uncontrolled supply, and vice versa, the consumption during periods in which the load control is made inoperative being charged at a higher price. The price change can be effected by a gear-change device in the kwh. register or in the prepayment mechanism of the meter, actuated in conjunction with the changeover in the operation of the load control. The necessary modification of apparatus and the extra cost entailed are both of a minor nature.

Siting of Power Stations

A PAPER by F. Favell (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 9; June 1942), on the considerations to be given to this subject, points out that in recent years the siting of electricity-generating stations has tended to be affected increasingly by non-technical considerations such as legal requirements, amenities, etc. These considerations become of special importance when a particular scheme is submitted to a public inquiry by the Electricity Commissioners under Section II of the Electricity (Supply) Act, 1919. The paper records some of the issues to be borne in mind when siting power stations in Great Britain and at the same time it refers to some factors which have a bearing on power station construction irrespective of location. It is divided into two main parts, the first dealing with considerations arising out of parliamentary legislation, and the second with more technical and practical problems. The first part refers to the Town and Country Planning Act, 1932; the Coal Act, 1938; the Coal Mines Act, 1930; and various other statutory requirements. The second part deals with chimney emissions; sewage effluent for circulating water; amenities; and alternative sites.

Californian Fisheries

THE report on the commercial fish catches of California for the year 1940 (State of California Department of Natural Resources. Division of Fish and Game. Bureau of Marine Fisheries. Fish Bulletin No. 58; 1942) makes available the summaries of commercial fish landings in each region of the State and also includes tables of numbers and nationality of the commercial fishermen and the number of boats of each type engaged in the fishery. A rapid development of the shark fishery is outstanding and is caused by the high price offered for liver oils of high vitamin A potency. This increase in the shark fishery, with intensive mackerel fishing and the large amount of sport fishing, has resulted in an increase of 350 boats in 1940–41 registrations over the previous year and is most noticeable in the group between 25 ft. and 39 ft. long. There has been a steady development of sport fishing in the ocean waters of Southern California, and the amount of small fish required as bait must be considered together with its effect on the several species used as bait. The statistical records include not only the sport catch itself but also the harvesting of the small-sized fishes used by the anglers for bait. Sardines and anchovies are the most important in the bait catch, comprising 98 per cent of the total, the fishes being 2½–6 in. long. A useful list of the common and scientific names of fishes, crustaceans and molluscs involved in the fisheries is given at the end of the report.

Inter-American Friendship through the Schools

THE U.S. Office of Education has issued as Bulletin No. 10, 1941, "Inter-American Friendship through the Schools", a report based upon a research study conducted by the Office of Education for the specific purpose of ascertaining the extent of inter-American studies, that are already a part of the school curriculum. The bulletin is based largely on the replies of school administrators to a questionnaire, and the central purpose of the investigation was to discover the opportunities of learning which the curriculum presents and the patterns of teaching relative to the development of inter-American understanding that are to be found in the elementary and secondary schools of the United States. From the 6,623 administrators to whom the questionnaire was sent, 2,471 replies were received in time to be tabulated for the report. Of these, 671 stated that Spanish was being taught, and one half of the schools reporting indicated that, although they did not offer Spanish, they provided a study of the other Americas in various courses given in English. No study relating to the other American republics in Spanish or in English was reported by 521 of the schools.

Dinosaur Find at Washington, D.C.

IT is stated by Science Service, of Washington, D.C., that the broken upper part of a saurian thighbone has been found in a new excavation being made for the D.C. filtration plant at Washington. The bone was identified as belonging to one of the sauropod group of dinosaurs by Dr. C. W. Gilmore, curator of vertebrate palæontology at the U.S. National Museum. Two finds of dinosaur bones have previously been made in Washington; they were of rather fragmentary fossils. Judging from the size of the present find, Dr. Gilmore said, the original animal was about ten feet high at the hips and fifty or sixty feet long, weighing approximately ten tons. Apparently, from the geological evidence, it was trapped in a small pond or mudhole and so perished. These creatures lived during the Cretaceous, about 150 million years ago.

Restoration of Historic Monuments in the U.S.S.R.

A SPECIAL committee for the registration and protection of architectural relics and historic monuments has been set up by the Soviet Government. It consists of leading members of the Academy of Sciences and architects, headed by Igor Grabar, a Stalin prizewinner. One duty of this committee will be to establish the amount and nature of the destruction and damage caused by the Germans in occupied districts and, where restoration is at all possible, to supervise the work.

Cosmic Ray Research

AN expedition of the Academy of Sciences of the U.S.S.R., led by Prof. A. I. Alikhanov, has arrived in Erevan, the capital of Soviet Armenia, to study cosmic rays. It will be in the field for about six weeks, making observations at the high-altitude meteorological station in the Alpaz mountains.

Recent Earthquakes

A SEVERE earthquake shook the towns of Santiago and Valparaiso and the region between the towns at about 1.30 a.m. (local time) on June 29. The *Intendencia*, headquarters of the Provincial Government, and other buildings were damaged in Valparaiso. Property was also damaged in Santiago, and for a while the electricity supply was interrupted. Thirty-seven people were reported injured. The earthquake was probably the most severe in Chile since 1927, when Talca and Concepcion were destroyed.

A moderate earthquake shook the town of Karachi at 8.30 a.m. approximately on the morning of July 3. No damage has been reported.

Free German Institute in London

A FREE German Institute is being founded by the science section of the Free German League of Culture in Great Britain. The aims of the Institute are: (i) to uphold and develop the valuable traditions of the Free German research work and teaching; (ii) to provide for interchange of opinion between Free German men of science and those of the United Nations; (iii) to strengthen the German refugee youth in the spirit of international understanding, and to enable them to help in re-shaping Germany's cultural life after the destruction of Nazism. The opening session will be held on July 17 at 7.30 p.m. at the Everyman Theatre, when an address will be given by Dr. Joseph Needham. Further particulars of the movement can be obtained from the secretary, Free German League of Culture, 36 Upper Park Road, London, N.W.3.

Announcements

THE honorary degree of D.Litt of the University of Oxford has been conferred on Commander Claude Schaeffer, of the Free French Navy, who is deputy curator of the Musée des Antiquités Nationales at Saint-Germain, and conducted important archæological excavations at Ras Shamra in North Syria.

A WHOLE-DAY conference is being arranged by the Nutrition Society, jointly with the Food Group of the Society of Chemical Industry, on "Dehydration of Foods and the Effect on their Nutritional Value", to be held at the British Medical Association House, London, on July 25. A later meeting, probably at the end of October, will deal with "Trace Elements in Nutrition". Further particulars of meetings can be had from the honorary secretary of the Nutrition Society, Dr. Leslie Harris, Nutritional Laboratory, Milton Road, Cambridge.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Raman's Theory of Specific Heat of Crystals

A DESCRIPTIVE article by Dr. W. H. George surveying some recent papers by Sir C. V. Raman and his school[1,2] having appeared in NATURE of May 16, we wish to make a few comments. A detailed criticism of Raman's paper will appear elsewhere.

(1) Raman rejects the result of lattice theory that the vibrational spectrum of a crystal consists of several (three or more) practically continuous branches, and contends instead that it consists of a few discrete vibrations. He bases this assumption on the observation that only a few sharp lines appear in optical absorption and scattering.

Lattice dynamics explains this fact by the optical selection rules: only those mechanical vibrations react with light waves which are in phase in a region of the order of a wave-length. As the wave-lengths concerned are long compared with the lattice constant, this selection rule restricts optical resonance to a practically monochromatic region in each branch of the spectrum. Hence the optical facts provide no argument against lattice dynamics.

(2) Raman[1] calculates the specific heat by superposing a few Einstein functions according to his interpretation of the spectrum. But in the majority of cases treated by his collaborators (Norris, Dayal, Anand, Venkateswaran[2]), these vibrations are not taken from optical data but chosen in such a way as to obtain a fair agreement for the specific heat. These calculations prove therefore only the well-known fact that a few Einstein functions can be fitted to the specific heat data of a solid. Nernst and Lindemann[3] showed in 1911 that even two frequencies in the fixed ratio 1 : 2 were quite sufficient for many substances. Born[4] has shown further that the higher branches of the vibrational spectrum cover a small frequency interval and can be replaced, for calculations on the specific heat, by a monochromatic vibration. But this is an approximation, and the fundamental fact that a system of $N \simeq 10^{23}$ particles has $3N$ modes of vibration cannot be explained away.

In the case of rock salt an attempt is made (Venkateswaran[2]) to relate some of the vibrations to peaks in the Raman spectrum; but strangely enough these were considered to be octaves of the required lattice vibrations. The frequencies of sylvine are all taken to be 0·78 of those of rock salt. All these assumptions are quite arbitrary and do not lead to results better than those given by previous calculations (see accompanying table).

(3) Raman's rejection of Debye's theory is based mainly on the alleged better agreement of Raman's formulæ with observation. But Debye's formula contains only one frequency and that not arbitrary, but expressible in terms of the elastic constants. It is very likely the best one-constant theory possible and serves remarkably well for monatomic substances. Its deficiencies appear at very low temperatures where particular phenomena are observed (for example, an increase in the value of the Debye parameter for NaCl with falling temperature). These have been satisfactorily explained by the rigorous lattice dynamics[5,6].

As an example, the experimental specific heat values found for rock salt by Clusius and Perlick[7] are tabulated below, together with the values calculated by Kellermann[6]; the last column is taken from a table calculated by Venkateswaran[2] applying Raman's theory.

$T°$ K.	C_v (expt.)	C_v (lat. theory)	C_v (Raman's theory)
10	0·0326	0·0328	0·036
20	0·310	0·317	0·28
30	1·150	1·154	0·96
40	2·380	2·380	2·04

(4) Raman rejects lattice dynamics because it uses the postulate of the 'cyclic lattice' for the calculation of the vibrations. Raman considers this an arbitrary assumption which leads to wrong results. In fact it is a reasonable method of approximation against which no mathematician has ever raised a doubt. The rigorous solution was known for the monatomic linear lattice, where it leads to the same results; in order to refute Raman's objections the correct solution for a di-atomic linear lattice has been worked out[8], and again complete agreement with the cyclic method was found. It must further be remembered that most of the well-confirmed results of the quantum theory of electrons in metals (electric conductivity, metal optics, etc.) are based on the cyclic method and can be considered as confirmations of it.

(5) Raman considers the frequencies of a lattice to a first approximation as those of the inner vibration of the single cell; but he suggests that there is an influence of the neighbouring cells which can be taken into account. This is in fact a reasonable and well-known way[4] of approximating to the higher (optical) branches; but it fails completely for the lower (acoustical) branches, and is therefore useless for monatomic lattices (all metals) where there are no higher branches, and, more generally, for substances (like the alkali halides) where it is not possible to consider the atoms in a cell as bound together with stronger forces than those connecting them to the neighbouring cells. It is in these cases that good confirmation is obtained for lattice dynamics in calculating the lattice energy, and elastic, optical, piezo-electric and other constants. All this would have to be abandoned if Raman's ideas were correct.

(6) Raman's theory has been devised to justify his interpretation of the diffuse X-ray scattering. It has been shown[9] that this interpretation is in contradiction with observations and with well-established theory, and that lattice dynamics accounts for the facts more satisfactorily. The diffuse X-ray spots are nothing but photographic images of the quasi-continuous spectrum derived from the lattice theory which Raman attacks.

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Absorption Spectra of 3-4 Benzpyrene

Evidence has been given[1] that benzpyrene emits various fluorescence spectra according to its physical state. Molecular benzpyrene, the monoclinic, the orthorhombic crystallized modification and the colloidal suspension in water fluoresce violet, green, blue and yellow respectively. The fluorescence spectrum of dissolved benzpyrene is unchanged in various solvents except for slight displacements of the entire group of bands[2]. We have now studied the absorption spectra with a low-voltage projection lamp as a light source for a continuous spectrum, which restricted the observation to the radiation transmitted by glass. It was found that the first broad absorption band of dissolved benzpyrene[3] has three components, α, β, γ, at 383, 380 and 377 mμ respectively in hexane (Fig. 1,*a*). They are of almost the same strength, but they behave differently in various solvents. While the α-component persists as the maximum, β and γ fuse and disappear more or less by polar effects due to the solvent.

The absorption spectrum of the blue fluorescing orthorhombic modification of solid benzpyrene (Fig. 1,*b*) is entirely different from that of the dissolved hydrocarbon. It shows a broad absorption band between 415 and 425 mμ which is accompanied by three narrower bands at 405–410, 392–396 and 384–387 mμ respectively. In order to delay the spontaneous transformation[1] of the metastable orthorhombic into the stable monoclinic crystals, very thin crystal films were prepared by evaporating a benzene solution of benzpyrene on cover glasses. A pile of six such films absorbs strongly enough to render visible the long wave-length portion of the absorption spectrum.

The monoclinic needles which fluoresce green, and their colloidal yellow fluorescent suspension in water, cannot easily be prepared in a state which is suitable for absorption spectroscopy. An indirect method was devised which allowed this difficulty to be overcome. It is based on the observation of Bowen and Sawtell[4] that the fluorescence efficiency of a fluorescent solution is usually independent of the wave-length of the exciting radiation within wide limits. Hence, if a continuous spectrum is focused on to the fluorescent substance in a layer so thin that the absorption is *feeble*, the absorption spectrum appears as fluorescent light. This can be recorded by a photographic plate if a thin film filter is placed between the fluorescent layer and the photographic emulsion, which completely absorbs the exciting short wave-length radiation and transmits the fluorescent light. Henri and Wurmser[5], by this technique, separated from a discontinuous spectrum the radiations which excite the fluorescence. Fig. 2 shows positives of 'fluorograms' of molecularly dissolved benzpyrene in Canada balsam (*a*), of the orthorhombic form as a single layer of sparsely distributed thin crystal squares of about 5 μ side under water (*b*), of the monoclinic form as a loose mosaic of microscopical crystal leaves on a cover glass (*c*) and of a colloidal suspension of benzpyrene in water (*d*). The fluorograms *a* and *b* repeat as luminous bands the dark bands of Fig. 1,*a* and 1,*b* although in a different strength. The same flat maxima of Fig. 2,*c* and 2,*d* at about 425 mμ establish the fact that the particles of the colloidal suspension are ultra-microscopical monoclinic crystals.

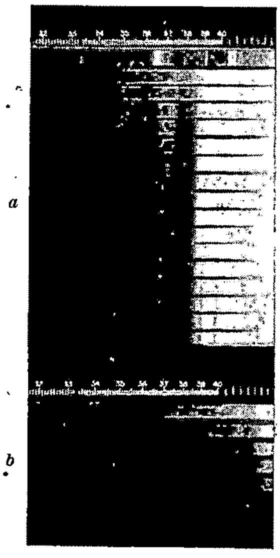

Fig. 1.
ABSORPTION SPECTROGRAMS (POSITIVES) OF BENZPYRENE.
(*a*) Dissolved in hexane, 1 : 100000; layers 2–32 mm. in thickness.
(*b*) Pile of 6 orthorhombic crystal films. Increasing exposures.

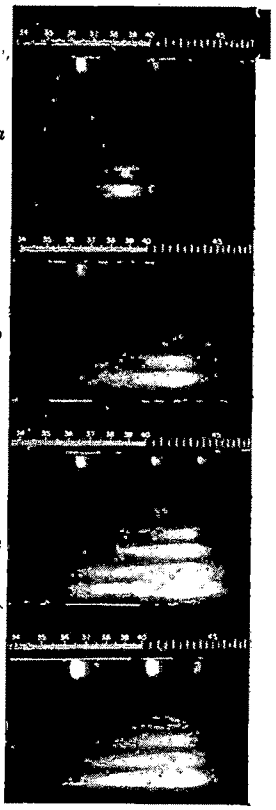

Fig. 2.
FLUOROGRAMS (POSITIVES) OF BENZPYRENE. INCREASING EXPOSURES.
(*a*) Dissolved in Canada balsam.
(*b*) Orthorhombic crystals in water.
(*c*) Mosaic of monoclinic crystals on glass.
(*d*) Colloidal suspension in water.

The method permits of recording—at the present stage, qualitatively—the absorption spectra of systems which are not suitable for the usual spectroscopic methods. This applies to colloid suspensions, microcrystals, and generally to mixed systems with a fluorescent component which must not or cannot be separated. Experiments are in progress to study the absorption spectra of biological fluorescent specimens in their original state, especially in connexion with problems of cancer research. It should be noted that a 'fluorogram' records the absorption spectrum of that component of a mixed fluorescent system (for example, a solid solution) which actually absorbs the light, irrespective of which component actually fluoresces. Thus colloidal suspensions of blue fluorescent pure anthracene and of green fluorescent anthracene which contains naphthacene both gave the fluorogram of anthracene only.

This research was carried out under a grant from the British Empire Cancer Campaign. I wish to thank Messrs. Adam Hilger Ltd. and Mr. F. Twyman for the loan of spectrographic equipment.

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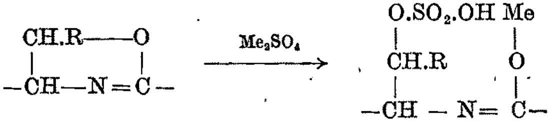
Oxazoline and Thiazoline Rings in Proteins

A study of the *O*-methylation of wool and silk with methyl bromide and methyl sulphate showed the extent of methylation could not be entirely accounted for as esterification of free carboxyl groups and we suggested that methylation of activated peptide linkages also took place[1]. We have now obtained evidence suggesting the activated peptide linkages are possibly those which have undergone condensation with the side-chains of β-hydroxy acids, for example, serine and threonine. By this condensation, oxazoline rings may arise, which Bergmann and Miekeley[2], from studies of the reactions of *O*- and *N*-benzoylserine, have considered possible constituents of proteins.



$$\begin{array}{c} \mathrm{CH.R}\text{——}\mathrm{O} \\ |\qquad\qquad| \\ -\mathrm{CH}-\mathrm{N}=\mathrm{C}- \end{array} \xrightarrow{\mathrm{Me_2SO_4}} \begin{array}{c} \mathrm{O.SO_2.OH}\ \ \mathrm{Me} \\ |\qquad\qquad| \\ \mathrm{CH.R}\qquad\ \mathrm{O} \\ |\qquad\qquad| \\ -\mathrm{CH}-\mathrm{N}=\mathrm{C}- \end{array}$$

We have now observed, in agreement with the above mechanism of methylation, that sulphuric acid is held firmly by wool methylated with methyl sulphate, and that methyl bromide, which would be less likely to open the oxazoline ring, gives less peptide methylation. We have also found that both acetyl and methyl groups can be introduced into wool, silk and collagen by the combined action of methyl alcohol and acetic anhydride. With wool, the extent of this new methylation is quantitatively similar to the peptide methylation obtained with methyl sulphate but not with either methyl bromide or iodide. For example, methyl sulphate introduced into different samples of the same wool 1·66 per cent CH_3; methyl bromide/iodide, 1·02 per cent CH_3; while acetic anhydride and methyl alcohol introduced 0·63 per cent CH_3. Hence, methyl sulphate introduced 0·64 per cent CH_3 to enolized peptide linkages as against 0·63 per cent CH_3 introduced by acetic anhydride and methyl alcohol. Methyl *p*-toluenesulphonate in methyl alcohol containing anhydrous potassium carbonate introduced 1·39 per cent CH_3 into this wool. Qualitative tests showed that some methylation of the tyrosine-hydroxyl may have occurred, but it is probable that cleavage of the oxazoline ring took place and both the peptide hydroxyl and the hydroxyl of the β-hydroxy acid were methylated.

Other evidence we have obtained suggests that free cysteine side-chains in reduced wool may form thiazoline rings in the same manner as serine side-chains form oxazoline rings, a possibility to which Linderstrøm-Lang and Jacobsen[3] have directed attention in their study of the reactions of methylthiazoline. Thus wool after maximum reduction with thioglycollic acid at *p*H 5[4] gives hydrolysates containing about half the original cystine-S as cysteine-S[5], but contrary to the findings of Harris and co-workers[4], we find that all the thiol groups in the reduced wool will not react with methylene iodide. After exposure to methylene iodide in buffer of *p*H 5, reduced wool ceases to give a nitroprusside reaction, but nevertheless, when hydrolysed yields 0·7 per cent of cysteine-S. A somewhat larger percentage of cysteine-S of the reduced wool fails to react with methylene iodide in buffer of *p*H 8. When oxygen is passed into buffer of *p*H 5 in which reduced wool is immersed, the cysteine-S is oxidized to cystine-S. If, however, the *p*H of the buffer is raised to 8, then about 0·7 per cent cysteine-S of the wool remains unoxidized, and again fails to give a nitroprusside reaction, unless guanidine is added. On the other hand, when the buffer of *p*H 8 contains guanidine, all the cysteine-S of the wool is oxidized to cystine-S. These results suggest that some of the cysteine side-chains form thiazoline rings, masking the thiol groups, which become available for reaction only to certain reagents when other experimental conditions are favourable.

Our observations have an obvious bearing on the unmasking of thiol groups when sulphur-containing proteins are denatured[6] and the increase in free reactive thiol groups which occurs when guanidine hydrochloride is added to solutions of myosin[7] and albumin[8].

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Optical Projection as an Aid in Studying Plane Spiral Coiling of Small Fossil Lamellibranchs

The use of optical projection in certain screw-gauges[1] and pivot-wear meters[2] suggested methods for examining the kind and degree of variation shown by plane spiral coiling in a group of small and well-preserved lamellibranchs (*Gryphœa incurva* (Sow.)) when researches upon these variations were extended[3] in this Department recently. Identical methods proved applicable to the study of small ammonites and other shells, whether fossil or recent, provided they were coiled in a plane spiral.

It was found that an accurate lantern-slide projector gave on a suitable screen a sharply defined silhouette of any lamellibranch up to 60 mm. in diameter when the fossil was held centrally in the lantern-slide carrier on a wax or 'Plasticine' pedestal, with the plane of coiling of the shell coincident with the focal plane of the projecting lens system.

For each specimen, by appropriately altering the distance between lantern and screen and sharply focusing its silhouette, a magnified but negligibly distorted image of constant diameter was obtained, the profile of which could be traced with a pencil on a sheet of opaque white paper, or tracing paper, attached to the screen.

Using opaque recording paper, comparisons between groups of these profiles were then facilitated by cutting along the profile outlines and superposing the 'cores' so separated from the sheets. With profiles drawn on tracing paper, the superposition of chosen profiles on an illuminated tracing desk rendered their comparison even simpler than with opaque paper.

Alternatively, the profile of a particular lamellibranch was directly compared with one of several accurately plotted spirals by adjusting the diameter and orientation of its projected silhouette on an opaque white paper screen which bore a group of these curves, drawn from a common centre in black ink. The rapidity of this method was outweighed to some extent by its failure to provide the more permanent records of profiles afforded by the other two methods.

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Death of St. Peter's Fish in Lake Huleh, Palestine

PALESTINE has been having some extremely cold weather and the past winter was probably one of the severest in recent years. Snow in Jerusalem and on the hills caused delight and amazement to much of the human population, but the bitter cold caused havoc and death among some of the fish in the north of the country.

In Lake Huleh, very large numbers of fish died and were eagerly collected by the local inhabitants. Altogether in three days early in January, more than 30 tons of fish were taken dead from the lake, which is a large number when it is realized that the total annual catch from the lake is only about 80 tons, of which 60 tons belong to the family Cichlidæ. It is, of course, impossible to estimate the amount of fish that died and which could not be collected, but it must certainly be large. Fish in Lake Huleh die whenever there is a very cold winter, but not on a large scale as on this occasion. The last time that appreciable quantities were killed was in 1921, but a few died of cold so recently as 1935. Usually in winter a large proportion of the fish congregate in the small rivers running into the lake and in the swampy areas around the shores. In these waters the temperature is higher than in the main part of the lake and the fish are protected from the floods of very cold water coming down from Mount Hermon.

In the past it was the custom to cut the reeds to keep the river mouths clear and so help the fish escape from the lake. In recent years, however, the reeds have not been cleared, and the river mouths are partially blocked, making it more difficult for the fish to enter. This factor may well have increased the destruction of the fish during the last cold spell. Among the dead only the family Cichlidæ, particularly the members of the genus Tilapia or St. Peter's fish, were represented, the remaining families, Cyprinidæ and Clariidæ, being apparently more hardy and able to withstand the cold. The European carp which have recently been introduced into the lake also came to no harm. Strange as it may seem, it was only the large Tilapia that were killed, though it is possible that the smaller specimens were in deeper water and the dead were not collected.

The lowest temperature recorded from the lake was 9° C., near the eastern shore. This does not seem very low, but probably the rate at which the temperature fell was more important in affecting the fish than the actual temperature. Since Lake Huleh is a shallow basin, fed by the Jordan River and by many small streams running down from Mount Hermon, and since all mountains in this region were thickly covered with snow at the time, it is probable that the water coming down was extremely cold and capable of causing local and very sudden drops in temperature in the lake, far below the 9° C. recorded.

The death of so many fish caused consternation in the country and much speculation as to whether the stock has been seriously damaged. Unfortunately it is impossible to know what proportion of the stock has been killed, for it is extremely difficult to estimate the number of Tilapia in the lake. The facts that the water is full of weeds and that much of the shore is swampy makes fishing difficult, and I do not believe that the lake is normally being fished as intensively as it should. A weight of 30 tons, or an amount equal to half the annual catch, of Tilapia is therefore probably not a large proportion of the stock as a whole. Also as only the larger fish appear to be affected and as there are huge areas of swamps, particularly in the great papyrus zone in the north, where the fish can take refuge, the damage is probably not so serious as at first appeared. Similar mass deaths must have occurred in the past during exceptionally cold years, but the lake is still well stocked and there is no evidence to suggest that the size of the stock is being reduced either by the rigours of the climate or by too intensive fishing—would that the same could be said of the depleted Sea of Galilee.

In actual fact it probably would not be a serious matter if the stock in Lake Huleh was damaged, for if the basin is likely to be drained in future, as has often been suggested, a large proportion of the fish will be destroyed in any case. Better that the lake should yield up some of its wealth now than in the future, when the need for locally produced food should not be so urgent.

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Russian-English Technical Dictionary

THERE is an urgent demand at the present time for an up-to-date Russian-English dictionary of scientific and technical terms. It is known that a number of Russian-English glossaries of specific terms have been compiled by various scientific institutions and individuals, and it is thought that it would be extremely helpful to scientific workers and technical translators if copies of these glossaries could be collected together and placed in the Science Library in London, where one complete set could be consulted.

Will, therefore, any institution or individual who has compiled a glossary of Russian scientific or technical terms, whether printed or in manuscript, please send a copy to the Secretary, Anglo-Soviet Scientific Collaboration Sub-Committee, The British Council, 3 Hanover Street, W.1, who will collect these for the Science Library.

It is hoped at a later stage to compile a large dictionary, but the immediate aim is to collect the different glossaries in one place where they can be consulted. Each glossary will be known by the name of its compiler.

E. J. RUSSELL
Chairman,
Anglo-Soviet Scientific
Collaboration Sub-Committee.

A RELATIVE CENSUS METHOD FOR BROWN RATS (*RATTUS NORVEGICUS*)

By DENNIS CHITTY

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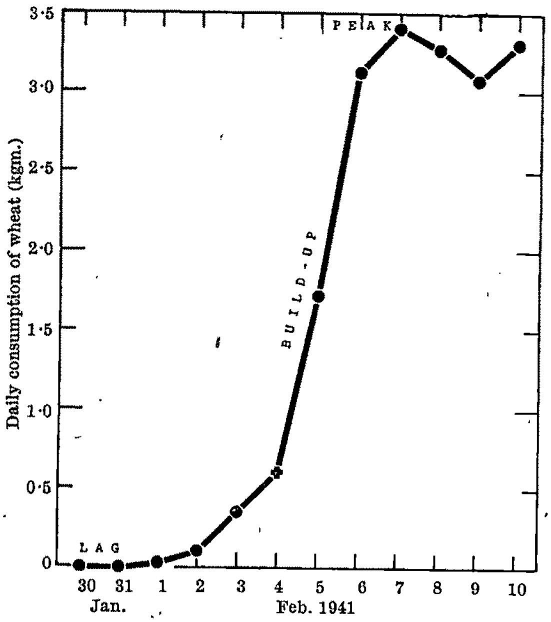
A USEFUL summary of census methods for mammals has been given by Dice[1]. Apart from those which involve killing the animals the following types have been used: counts of droppings, tracks, homes, or the animals themselves; live trapping followed by marking and releasing. Live census methods for rats have not, except in ship deratization work, been well developed along these or other lines. *Droppings* are the most reliable signs used by inspectors on board ship[2]; and their estimates of infestation usually check very closely with numbers found dead after fumigation[3]. The operation, however, is a highly skilled one, and since allowance must be made for the type of food and rate of desiccation of the droppings, probably cannot well be applied elsewhere. *Tracks* and runways in mud, dust, snow, etc., show rat distribution but give little indication of numbers. A white powder such as plaster-of-Paris is useful for showing up footprints. *Homes*. In habitats such as hedge banks a count of holes may be made; but in buildings the number is seldom related to the density of the rats. Nests of *Rattus rattus* subspecies can be seen in the trees in Hawaii[4,5] but nests of brown rats are not as a rule easily found. *Brown rats themselves* are largely nocturnal, and no representative fraction of the population is likely to be seen (on ships not more than one in twenty)[2] except by destruction of the habitat or by bolting the rats with gas or ferrets. (The method is not good in premises such as shops.) *Live trapping*, marking and releasing has been carried out at this Bureau, but involves a good deal of work and technical difficulty. *Other signs* of the presence of rats include their odour, damage to food and structures, the black, oily smear left along runways and an occasional dead rat[2].

Prebaiting for one or more days is a well-known system of rat control, but usually only small amounts of prebait are laid before the same food is given with poison added. We have termed this system 'token' as distinct from 'surplus' prebaiting which, so far as is known, has only been used before in Hawaii. Here Pemberton[5] and Doty[6] discovered that when prebait was given in excess the take increased daily for about a week as more and more rats were attracted (chiefly *Rattus norvegicus* and *R. hawaiiensis*). By mapping the distribution and amount of poison bait afterwards eaten, Doty showed the relative distribution of rats in the cane fields. In its essential features this author had already described a type of feeding behaviour discovered independently a few years later at Oxford.

Surplus baiting has been developed here as an essential part of rodent control research for the Agricultural Research Council, in the course of which it has been necessary to obtain accurate field measurements of relative population density. Wild brown rats are offered more wheat than they can eat, and, as a rule, their maximum daily consumption is used as the index of relative abundance. Wheat, which is eaten with little waste, has provided a standard medium without which these experimental results could not have been obtained. Oats and barley are less suitable as they are husked, and meals are more subject to the effects of weather and are bulkier to carry.

Fig. 1 is a typical curve showing consumption of wheat by brown rats at a prebaiting point on a rubbish dump. A 'lag', sometimes up to twelve days, may be expected before the start of feeding if the prebait is put under newly placed cover (here, an old tin trunk was used). This delay is chiefly due to rats' intense suspicion of alterations to their environment. 'Build-up': the number of prebaited rats increases for several days and a 'peak' rate of feeding is reached which is seldom exceeded unless the colony is being reinforced by breeding or immigration.

Storing. Certain types of food are stored by rats, but we have no evidence that this has happened when wheat is used as prebait, though mouthfuls may be taken away and eaten nearby. Even at places where baiting was carried on for weeks at a time no stores were ever found, and frequently after the supply had been reduced for a day the take was temporarily increased when surplus was again provided. This and other evidence of hunger shows that no important food reserves had been collected. Also if the bait is changed to a non-portable type such as wheatmeal the daily consumption is about the same.



CONSUMPTION OF WHEAT BY BROWN RATS AT A PREBAIT STATION PLACED ON JANUARY 29, 1941, ON A RUBBISH DUMP. DAILY CONSUMPTION IN GM. AS FOLLOWS: 0, 0, 30, 108, 350, 600 (NO SURPLUS LEFT), 1,710, 3,127, 3,402, 3,270, 3,077, 3,306.

Fraction of population prebaited. From the fact that a whole population can be poisoned from properly placed stations it is concluded that all the animals can be prebaited.

Proportion of prebait in total diet. This no doubt varies from place to place, and temporary drops in take after the build-up are probably due to other foods being discovered; but as a rule the fluctuations are surprisingly small. In a few cases more attractive forms of prebait must be used than wheat; but except where large amounts of food are stored without protection, as in ricks and certain warehouses, no difficulty is found in getting rats to take the bulk of their food from stations conveniently placed and regularly supplied with wheat. For example, in a certain restaurant extensive damage was being done until, after surplus baiting was started, the rats confined their attention almost entirely to the wheat.

Wild rats' consumption of prebait (per kgm. body weight) is being compared in different environments and with the amount eaten in captivity. A number of rats are trapped alive from a prebaited population and the subsequent drop in take is attributed to their removal. The rats are weighed, sexed and fed for a few days in a large outdoor cage. Experiments in progress may make it possible to convert the present relative census method into one giving the approximate number of rats.

Disturbance. The provision of unlimited food may sometimes alter existing conditions, and immigrants will be attracted if the baiting points are not, as they should be, spaced out to cover the whole colony at once. A fluctuating food supply is frequent among rat colonies and short periods of prebaiting seem unlikely to produce results that will invalidate the census or disturb the population. If token baiting is carried out during the build-up period, a surplus need only be provided for two or three days afterwards.

Specificity of the method. Animals other than rats and mice (the latter, when present at all, eat relatively little) can be kept from the bait by providing cover such as a large box with a 3-in. diameter hole; but it is most convenient to use small containers of a standard design developed by the Bureau.

Summary. A method of relative census for brown rats consists of measuring the feeding capacity of the population. It is simple to carry out, applicable in a wide variety of habitats and involves a minimum of interference with the rats. No other suitable technique is known that does not involve killing the rats. The method should be applicable to other populations which consist of only one species of small mammal.

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FUTURE OF TRANSOCEANIC TELEPHONY*

TELEPHONY was born from telegraphy by an expansion of the band of frequencies employed in the electrical transmission of intelligence. More recently, further expansion has produced improvement of quality of transmitted speech and an increase of the number of simultaneously transmitted conversations. To-day, speech can be transmitted overland perfectly for any distance and with hundreds of conversations at once over a single coaxial line.

Telegraphy takes a certain band-width measured in cycles per second for a particular speed of signalling measured in words per minute. A telegraph machine printing 60 words a minute needs about 100 cycles and intelligible telephone communication requires about 1,000 cycles. 3,000 cycles for commercial telephony is now a reasonable engineering standard although it does not provide for perfect speech transmission. Speech frequencies cover about 8,000 cycles, though frequencies above 4,000 contribute little to intelligibility or quality. The range of the normal human ear is about 15,000 cycles and perfect transmission of music requires that band-width. Little is lost, however, if the music is limited to 8,000 cycles. Television requires from 20,000 cycles for a recognizable human face to 20 millions or more for vision as well defined as in standard cinema practice, but in present commercial practice the band-width is limited to about 3 million cycles.

The available frequency range of a transmission line of given band-width can be allocated to telegraphy, telephony or television at will. Twenty printing telegraph channels with adequate separation cost in frequencies about as much as one ordinary telephone channel, but for a television channel the equivalent, in frequencies, is 1,000 telephone or 20,000 printing telegraph channels.

A major advance in trans-Atlantic cable telegraphy ensued with the introduction of the permalloy-loaded cable in 1924, having a band-width many times that of corresponding non-loaded cables. The fastest loaded trans-Atlantic cable has an effective frequency band of more than 100 c./s. and can carry four times as much traffic as a non-loaded cable of the same size and length. Development of permalloy loading led to the manufacture of a 20-mile section of this type of cable in 1930, and while all the measurements in the laboratory, at sea, and from shore confirmed the technical soundness of the proposal to install such a cable, the project was postponed temporarily because of general business depression and later, indefinitely, because of the improvements in trans-Atlantic radio communication.

In the development of radio for transoceanic communication, only two isolated ranges of the band spectrum are utilized, each of which is comparatively narrow. The low-frequency range is a band some tens of kilocycles wide with a top of about 100 kc. In the 1920's the band of frequencies useful for long distances was widened several hundredfold by the discovery of short-wave transmission at frequencies in the range of 3–30 mc. This put transoceanic radio communication on its present world-wide basis. Short waves contributed also to the demand for service, since the apparatus required for short-wave circuits cost less than that for long waves.

The trans-Atlantic telephone started in the relatively cramped long-wave band and then moved into the freer region of the short-wave range. Speech was first sent across the oceans from Arlington, Va., to Paris and to Honolulu in 1915. For its accomplishment the first high-power vacuum tubes and the first master-oscillator, power-amplifier tube transmitter were evolved. In the long-wave range and for trans-Atlantic distances, radio is seriously limited in respect of the high noise-level, particularly in summer, due to thunderstorms in northern latitudes, and of the weakness of the received signals during the sunset and sunrise periods. The development of the water-cooled, high-power vacuum tube made possible high-power amplifiers to deliver tens of kilowatts needed to lift the signal higher above the level of atmospheric noise. The influence of static was further reduced by the use of directive receiving antennas. Additional improvement was provided by the technique of single-sideband transmission first used on wires. These and other developments assured fairly reliable telephone connexions and in 1927 public service was opened jointly by the General Post Office and the American Telephone and Telegraph Co. The carrier frequency was 60 kc./s., corresponding to a wave-length of 5,000 m.

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* Substance of the thirty-third Kelvin Lecture delivered before the Institution of Electrical Engineers by Dr. Oliver E. Buckley, of the Bell Telephone Laboratories, on April 23.

The opening of the first trans-Atlantic short-wave telephone circuit in 1928 followed close on the long-wave circuit; and was followed in turn by additional short-wave circuits in 1929. Opportunities for greatly improving short-wave transmission then appeared so that the project of the second long-wave circuit was deferred and, later, postponed indefinitely. More recently, experiments have demonstrated the feasibility of transmitting two channels at different frequencies using the same transmitting equipment.

Short-wave radio gives less attenuation, lower noise and a wider frequency band in which to operate compared to long waves for transoceanic service. For a radio-telephone connexion between the United States and England the cost of short waves for an approximately comparable quality of service is about one half that of long waves. The wider band provides an opportunity for the service to expand, and it is hundreds of times wider than the long-wave band. These advantages have been reflected in the rapid growth of short-wave transoceanic telephony; at the beginning of 1939 there were in service throughout the world about 170 important long-distance short-wave telephone circuits, of which five were in regular use between the United States and Europe. There has grown up also a host of short-wave broadcasting channels, the better co-ordination of which had yet to be worked out.

Short-wave transmission, however, is susceptible to periodical interruption, particularly around the maxima of the eleven-year sunspot cycle. Short waves are also affected adversely by various types of signal distortion as the received signal is usually made up of several components which have travelled over different paths. Sometimes these paths all lie along the same great circle but involve different numbers of reflexions between the earth and the Heaviside layer. Sometimes signal components arrive over other than the great-circle path. Occasionally components travel along the longer of the two great-circle paths between the transmitter and receiver, or even clear around the world, producing 'round-the-world echo'. Interference between waves arriving over different paths results at times in 'general fading' caused by variations in the level of the whole band and at other times in 'selective fading' in which portions of the speech band are affected differently.

Single-sideband transmission has, however, helped in eliminating the periodical fading out of the carrier signal which particularly gives rise to a harsh, grating received speech. The multiple-unit steerable antenna (MUSA) recently developed in Bell Telephone Laboratories reduces selective fading by combining signals arriving over different paths or by eliminating all signals except those arriving over one path. Additional antenna directivity makes possible operation in periods of reduced signal strength, though it does not eliminate circuit interruptions at times of very severe disturbance. Single-sideband transmission and the 'MUSA' are now in regular use on the New York–London telephone circuits.

The most significant recent development in land-line telephony is that of broad-band transmission by carrier methods over open wires, cables and coaxial conductors of a considerable group of telephone bands on closely spaced channels. Over open-wire lines and over pairs in lead-covered cables, 12 telephone bands spaced at 4,000-cycle intervals are commonly transmitted in a group occupying a total band-width of 48,000 cycles. With coaxial conductors the band has been increased to 2 million cycles, giving frequency space for some 500 telephone channels, and it may be expanded still further.

The application of broad-band methods to transoceanic radio telephony are likely. Commercial success has already been achieved with small numbers of channels in the Holland–East Indies and the United States–England single-sideband systems. By applying the principles of negative feedback, Bell Laboratories engineers have developed a short-wave transmitting amplifier of 200 kw. capable of handling twelve or more closely spaced telephone channels.

When the sun is over the mid-Atlantic in summer there is available a useful band about 4 mc. wide, in the 14–18 mc. range. These short waves cannot be counted upon, however, to be duplicated very often for simultaneous use at different locations throughout the world. The available 4 mc. band must be divided therefore to meet a large number of requirements, and public service telephony across the Atlantic deserves something like a tenth of the total facilities in this band. This would mean an allocation of 400 kc. or 100 one-way telephone channels, yielding 50 or more two-way circuits realizable under the natural limitations of the medium and the other requirements placed upon it.

We can anticipate with confidence a great growth of trans-Atlantic telephone traffic, but in proportion as the demands for service grow and we come closer to the realization of the ultimate physical possibilities, the more serious becomes the threat of interruption to this service by magnetic storms.

These conclusions lead to reconsideration of the trans-Atlantic telephone cable as an auxiliary to short-wave systems. A single-channel cable would be of little value in supplementing a radio-telephone service of so many channels as there may be in the future. Moreover, the cable must also be capable of carrying a considerable group of telephone channels, and much progress has been made in that direction.

A multi-channel telephone cable to cross the ocean would have to be provided with intermediate repeaters on the ocean bottom, the repeater housing being incorporated within the cable structure. A small diameter housing incorporated as a part of the cable was therefore developed, the whole structure being so flexible that it could be bent around a cable drum.

The repeater housing comprised first a succession of pressure-resisting steel rings each having a diameter of about 1½ in. and a width of ¾ in. Over these is slid a succession of thinner steel rings of the same width but overlapping the joints of the inner rings, the whole forming an articulated cylinder about 7 ft. long. An annealed copper tube with water-tight end seals is placed over this cylinder. Within the housing the repeater elements are separately contained in plastic cylinders about 6 in. long, loosely fitting inside the inner steel rings. Connexions between these units are made with flexible conductors. D.C. constant-current power must be fed to the repeater over the cable, and an operating potential of 2,000 volts to earth, oppositely poled at the ends of the cable, was assumed. The repeater elements must rarely require attention and twenty years without replacement of parts was assumed to be reasonable. The problem of life and maintenance is principally one of a rugged long-lived vacuum tube. Ordinary vacuum tubes have limited service life on account of evaporation of material from thermionic cathodes. By making the level of transmitted signals relatively low, the space current may be kept very small and by making the cathode surface relatively large, this small current can be obtained at a temperature so low that the cathodes of the tubes may be expected to last for a very long time.

The number and spacing of repeaters depends on the length and design of the cable. For a cable 2,000 miles long to connect Newfoundland and Great Britain, forty-seven repeaters spaced 42 miles apart would provide for the transmission of a band 48,000 cycles wide.

The repeater is a one-way device and to provide two-way conversations two cables have been assumed, one directed eastward and the other westward. Assigning 4,000 cycles per channel, there would be room for twelve telephone circuits and as many as twenty-four fairly satisfactory 2,000-cycle channels could be provided.

As to the costs of such a cable for broad-band wire telephony to England via Newfoundland, even at somewhat higher annual charges than usual the total cost per telephone circuit for two cables with associated equipment would be comparable with that of prospective short-wave radio systems.

Short-wave radio links have a great advantage in affording direct connexion between points on the globe far apart, and the tendency has been to establish short-wave connexions directly between large centres rather than through extensive land-line links. The introduction of broad-band methods for transoceanic radio telephony will tend to favour centralizing radio traffic at a smaller number of more important terminals, but it is scarcely to be expected that all transoceanic radio traffic will thus be concentrated.

The world-wide transoceanic network of the future may well envisage a net comprising a large number of light linkages plus a small number of heavy linkages over the most important routes. The light linkages will represent direct short-wave single-channel or twin-channel connexions using relatively small power. The heavy linkages will comprise highly developed powerful broad-band short-wave radio systems making full use of frequency and directional diversity supplemented by broad-band submarine cables and in a few cases by long-wave radio as well.

One possible way to estimate the future for trans-Atlantic telephony is to compare the flow of telegraph traffic, say, between London and New York, with that between New York and San Francisco. Difference in community of interest is compensated to some degree by the difference in size of London and San Francisco.

This comparison may be made on the two bases of telegraph traffic, using the total number of words transmitted in a single year as the measure, and of the number of public service telegraph messages, excluding Press service, leased-wire service and code and cipher messages. In each case the estimate is based on terminating messages only. Data for the year 1937 are available and this particular year represents something between the 1929 peak and the trough of the succeeding depression.

On the first basis of comparison the total number of telegraph words transmitted over the two routes in 1937 was approximately the same. On the second basis the number of telegraph messages was about seven times as great between New York and London as between New York and San Francisco. The wide discrepancy between the two comparisons is doubtless accounted for partly by rates and partly by the character of business and social intercourse. Of the two, the second, which is based on plain-word public-service messages, appears more significant in relation to potential demand for telephone service, since public message telegraphy, as a somewhat closer approximation to the informal exchange of ideas by telephone, may be a better index of telephone demand. The potential demand for telephone connexion between New York and London is thus probably somewhere between one and seven times that between New York and San Francisco. Actually, in 1937 the telephone traffic between New York and San Francisco was about three times that between New York and London so that not more than a third, and possibly not more than a twentieth, of the potential telephone demand has been realized.

Assuming that the same ratio of potential to realized demand exists for all European–North American connexions as for the New York–London connexion, it may be estimated that 15–100 circuits will be needed across the North Atlantic depending on costs, but a demand for forty or more telephone circuits may justifiably be predicted in the reasonably near future.

To provide this increase in number of circuits, and to approach land-line standards of reliability and quality of service, all three systems—short-wave, long-wave and repeater cable—will need to be used. The bulk of the trans-Atlantic business will be handled on the short wave, but such an important service would have to maintain a higher standard of reliability than short-wave circuits alone can provide. A cable between America and Britain would provide this reliability, and it would set a high standard of transmission performance in competition with short waves.

It may not be necessary to wait until the growth of trans-Atlantic telephone business provides enough traffic to utilize fully a cable of the type described. When the engineers can give reasonable assurance of the cable it is believed that it will not have to await complete economic justification, because of the tremendous importance which it would have in ensuring privacy and continuity of trans-Atlantic telephone service.

There are already partly developed inventions which might greatly modify the picture of transoceanic telephony as set out above. One such is the 'vocoder', an instrument which dissects speech, transmits it in code and recreates it at the other end of the line. With vocoders a hundred or more simultaneous conversations might be carried by a pair of repeatered cables. While the vocoder would transmit the primary elements of conversation it would not provide all those qualities of speech which words alone do not convey. The vocoder gains in band width at the cost of naturalness of speech, but even so it may find important application.

Other inventions may extend the band-width available for transoceanic communication far beyond the range here discussed. Projects such as repeater ultra-short-wave radio systems and undersea wave-guides, which to-day appear fantastic, may some day come within the range of practicability.

THE RECORD OF PICTURESQUE BRITAIN

By DR. VAUGHAN CORNISH

THE second year's work of artists engaged in recording picturesque features of England and Wales is now on view at the National Gallery, London. This valuable work, initiated by a committee set up by the Ministry of Labour and National Service, has been made possible by a grant from the Pilgrim's Trust. It is intended that the drawings (which are the property of the Trustees) shall ultimately form a permanent collection.

A special feature of the present exhibition is a group of drawings of Windsor Castle by John Piper, lent by H.M. The Queen, who commissioned their execution after last year's exhibition. The rest of the present collection of drawings (about two hundred in number) includes examples from twenty counties, of which ten counties are additional to those comprised in last year's exhibition.

Of picturesque Buckinghamshire a charming corner house in Winslow and the red-brick town hall of Buckingham are faithfully depicted by Stanley Anderson, R.A. Notable examples of London and its environs are the Embankment, Pimlico, by Edward Walker, and The Admiral's House, Hampstead, by Norman James. Petersham and Ham in Surrey have been recorded in detail, both on account of the beauty of their seventeenth-century houses and the special risk of demolition owing to the nearness of London. Among these pictures are a general view of Ham Common, and the representation of two houses at Petersham with Dutch gable-ends facing the road.

Of towns in Hertfordshire, the steep street of Bishop's Stortford is shown in a charming pen-and-ink sketch by S. R. Badmin. The broad, open spaces of flat Suffolk are well shown in Martin Hardie's water-colour of Bawdsey Ferry.

On the western side of England, Ledbury in Herefordshire has been selected for its remarkable timber-frame houses; and, finally, crossing to Wales, Mona Moore's water-colour shows the low stone houses, of the fifteenth and sixteenth centuries, offset by a mountainous background.

In addition to buildings, the record of articles in use comes within the scope of the record of picturesque Britain. An interesting example is shown in Kenneth Rowntree's careful drawing of a coracle, the primitive boat which has come down from British times.

As this present World War goes on, we need to consider more carefully than hitherto the importance of the beauty of town and countryside in relation to the nation's welfare. When we look back to the early eighteenth century, we find the beauty of the countryside enhanced in both building and planting by the educated taste of the great landowners. Without attempting to consider the justification or otherwise of the taxation to which they are now subject, there is no doubt that if their mansions and parks be not preserved, the nation will lose one of its greatest assets of beauty. At the present time, it is of great importance to realize that an environment of beauty is no mere luxury but an essential condition for the happiness and spiritual welfare of the nation. If, however, such an environment is to confer its full benefit, the nation as a whole must be educated in the appreciation of scenery, both natural and architectural. Now that, in the twentieth century, education is no longer confined to the well-to-do classes, the proper understanding and full enjoyment of the æsthetics of scenery can be brought within the reach of all, if, but only if, the subject is brought properly before the attention of the whole community. Picture galleries are, of course, a help, but by no means sufficient. The most evident means at the command of the Government is a weekly broadcast allotted to the systematic teaching of the æsthetics of scenery.

COMMUNICATION PROGRESS

IN a lengthy article entitled "Milestones of Communication Progress" (*Elect. Comm.*, 20, No. 3; 1942), H. T. Kohlhaas presents a comprehensive review of the developments in electrical communication which have occurred within the last twenty years. In the planning and co-ordinating of long-distance telephone communication, an outstanding event was the creation in 1924 of the International Consultative Committee on long-distance telephony in Europe, following a proposal made by Sir Frank Gill in his presidential address to the Institution of Electrical Engineers in 1922. Between 1923 and 1926 a succession of recorded steps led to the establishment of the first trans-Atlantic radiotelephony circuit between the United States and England. The first Madrid–Buenos Aires radiotelephone circuit was inaugurated in 1929 and it was followed in 1930 by the first radiotelephone circuit between the Americas. In 1931 the first demonstrations of single sideband short-wave radiotelephony were carried out between Buenos Aires and Madrid and between Madrid and Paris, establishing the now well-recognized improvements in transmission efficiency and the economies which this method makes possible.

In 1931 and the following years outstanding developments in the ultra-high frequencies were described. Long-distance telephone communication was established across the English Channel on approximately 1,600 mc. using very sharp beams. Work in this general field was continued with great activity and publications appeared on propagation of these very high frequencies in 1936 and 1937, the latter including a description of the first multi-channel ultra-short wave telephone link. Later, work on ultra-high frequencies was directed also to television transmission. On one hand, there were references in 1939 to the Eiffel Tower television station delivering 30 kw. to an exceptionally long feeder over the wide band of frequencies necessary for television, and on the other, to transmission over dielectric guides at frequencies from 1,000 mc. to 30,000 mc., using various types of positive grid triodes, klystrons, magnetrons or other tube structures.

High-power broadcasting on intermediate frequencies and high frequencies took a prominent place at this period. The Prague station with 120 kw. carrier was described in 1932 and was followed two years later by the Budapest station with the same carrier power. The latter was unique for its anti-fading mast antenna over 1,000 feet high, the highest antenna ever constructed. On higher frequencies, mention was made of two British Empire transmitters added in 1937 at Daventry, rated at 50 kw. carrier power at 22 mc. Early long-distance telephone communication to ships at sea was also recorded: on the *Berengaria* in 1929; the *Belgen-*

land in the winter of 1930–31 and the *Empress of Britain* in 1931–32. Successful conversations were held with London when a ship was in the China Sea and with New York when at Alexandria. Service to the *Majestic* was opened on February 14, 1930, at first for incoming calls only.

Important work on automatic direction finders was done in 1934 and onwards and an aeroplane automatic radio compass was described in 1936. This equipment was introduced in the United States in 1937, and important experiments were made and papers published on night error and mountain effects. The subject of ground direction finders avoiding polarization errors by the use of spaced vertical antennæ with high-frequency transmission line to distant receivers was studied around 1938 as was that of aerial navigation.

Less spectacular, but fundamental, were developments in automatic telephony and transmission in which field the application of machine switching to large areas, the rapid expansion of rural automatic networks and, in recent years, schemes involving complete national dialing in some of the smaller European countries, either on a timed and zoned metering basis or on an automatic ticketing basis, were outstanding examples. These national dialing schemes led to the development of a commercially practicable system for automatic toll ticketing, each ticket containing a complete record of each subscriber's telephone call. In 1937, 1939 and 1940 a series of articles appeared showing how automatic toll ticketing was developed and introduced commercially.

The wire transmission systems went through an evolution just as remarkable as that of automatic switching. References to the first carrier telephone systems in Brazil and Australia appeared in 1924 and 1925 respectively; the first loaded and repeatered long-distance French telephone cable, in 1927; and the first twelve-channel carrier systems and the first coaxial cable in England in 1937. Several lines of development, continued year after year, are only now yielding their reward in connexion with war efforts, and this is especially true of much of the work done on aerial navigation, on direction finding and in the general field of ultra-high frequencies. This 43-page review contains much of historical interest, and concludes with a list of 159 references to papers, etc., published during the period surveyed.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Tuesday, July 14

Institute of Petroleum (joint meeting with the Institution of Chemical Engineers and the Chemical Engineering Group of the Society of Chemical Industry) (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 5.30 p.m.—Dr. M. Ruhemann: "The Separation of Gases".

Wednesday, July 15

Institute of Chemistry (London and South Eastern Counties Section) (at 38 Russell Square, London, W.C.1), at 6 p.m.—Dr. J. Grant: "Chemist versus Forger".

Thursday, July 16

London School of Hygiene and Tropical Medicine (at Keppel Street, London, W.C.1), at 2.30 p.m.—Prof. Major Greenwood, F.R.S.: "Civilian Hazard of Life in this War and in the Last—a Profit and Loss Account for 1915–16 and 1940–41".*

Friday, July 17

Physical Society (Optical Group) (in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. F. Twyman, F.R.S.: "The Interferometer in Lens and Prism Manufacture".

APPOINTMENTS VACANT

Applications are invited for the following appointments on o before the dates mentioned:

Headmaster of the Portsmouth Grammar School—The Chairman of the Governors, Paymaster Rear-Admiral G. Grant, 4 Ol Cottages, Church Hill, Midhurst, Sussex (July 18).

Teacher of Physics, Mathematics and Engineering Science and a Teacher of Workshop Practice, in the Doncaster Technica College—The Chief Education Officer, Education Offices, Doncaste (July 21).

Veterinary Investigation Officer—The Secretary, West o Scotland Agricultural College, 6 Blythswood Square, Glasgow (July 30)

Two Demonstrators (Male or Female) in Anatomy—The Registrar, The University, Sheffield (July 31).

Lecturer in the Department of Chemistry—The Registrar, University College, Southampton (August 4).

Teacher for Day and Evening Engineering Classes, and a Teacher for Engineering Workshop Practice and Metalwork—The Principal, County Technical College, Gainsborough.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Memoirs of the Cotton Research Station, Trinidad. Series A Genetics, No. 18: Anthocyanin Pattern in Asiatic Cottons. By R. A Silow and C. P. Yu. Pp. 249–284. (London: Empire Cotton Growin Corporation.) 2*s*. 6*d*. [22

Royal Meteorological Society. Bibliography of Meteorologica Literature. Prepared by the Royal Meteorological Society with th collaboration of the Meteorological Office. Vol. 5, No. 2, July–December 1941. Pp. 13–30. (London: Royal Meteorological Society. 2*s*. 6*d*. [25

Hertfordshire County Council. The School Child and the School Canteen. An Inquiry undertaken by F. LeGros Clark and presented to the Education Committee. Pp. 36. (Hertford: County Hall.) [256

Annual Reports on the Progress of Chemistry for 1941. Vol. 38 Pp. xxxii+326. (London: Chemical Society.) 15*s*. [25

Geological Survey of Great Britain: Scotland. Wartime Pamphlet No. 27: The Oil-Shales of the Lothians—Structure. Area 1: West Calder. By Dr. J. E. Richey; with Appendix by W. Manson and Contributions by W. E. Graham. Pp. 42. (London: Geological Survey and Museum.) 1*s*. 10*d*. [17

Other Countries

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 6 (Monograph No. 5): Pupil Personnel Services as a Function of State Departments of Education. By David Segel and Maris M. Proffitt. (Studies of State Departments of Education.) Pp. vi+84. 15 cents. Bulletin 1941, No. 7: School Library Administration as Annotated Bibliography. Prepared by Nora E. Beust. Pp. vi+82. 15 cents. (Washington, D.C.: Government Printing Office.) [226

University of Illinois: Engineering Experiment Station. Bulletin Series No. 334: The Effect of Range of Stress on the Fatigue Strength of Metals. By James O. Smith. Pp. 49. 55 cents. Reprint Series No. 22: Eighth Progress Report of the Joint Investigation of Fissures in Railroad Rails conducted by the Engineering Experiment Station, University of Illinois, in co-operation with the Association of American Railroads and the Rail Manufacturers Technical Committee. By Herbert F. Moore. Pp. 38. 15 cents. (Urbana, Ill.: University of Illinois.) [226

Proceedings of the United States National Museum. Vol. 92, No. 3139: The Chrysomelid Beetles *Luperodes bivattatus* (LeConte) and *Varicornis* (LeConte) and some Allied Species. By Doris H. Blake. Pp. 57–74+plates 5–6. Vol. 92, No. 3140: Notes on the Classification of the Staphylinid Beetles of the Groups Lispini and Osoriinæ. By Richard E. Blackwelder. Pp. 75–90. (Washington, D.C.: Government Printing Office.) [226

U.S. Department of Agriculture. Farmers' Bulletin No. 1886: The Beet Leafhopper. By W. C. Cook. Pp. ii+21. (Washington, D.C.: Government Printing Office.) 10 cents. [236

University of California Publications in Zoology. Vol. 46, No. 1: The White-crowned Sparrows (*Zonostrichia leucophrys*) of the Pacific Seaboard; Environment and Annual Cycle. By Barbara D. Blanchard. Pp. iii+178 (20 plates). (Berkeley and Los Angeles, Calif.: University of California Press; London: Cambridge University Press.) 2 dollars. [256

Forest Bulletin No. 106 (Silviculture Series): The Control of Lantana by a Sodium Chlorate Spray. By A. L. Griffith. Pp. vi+8+2 plates. (Delhi: Manager of Publications.) 6 annas; 7*d*. [17

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 37: Milk Records of Cattle in Approved Dairy Farms in India. Vol. 2 (Records received during 1937–38), Part 2: Buffaloes. Compiled by the Animal Husbandry Bureau, Imperial Council of Agricultural Research. Pp. vi+325–614. (Delhi: Manager of Publications.) 5 rupees; 8*s*. [17

Catalogues

Electric Furnaces. (Publication 51.) Pp. 4. (London: Johnson, Matthey and Co., Ltd.)

Glo-Pass Security System. Pp. 12. (London: Colloidal Research Laboratories, Ltd.)

Chance-Parsons Optical Glass. (CP.400.) Pp. 22. (Smethwick: Chance Brothers and Co., Ltd.)

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SCIENTIFIC MEN IN WAR-TIME

Strategy

FROM the outbreak of war in 1939—and indeed for a long time previously—it was obvious that the knowledge possessed by scientific men and engineers would be of decisive importance in the coming struggle. Means had to be found of making this knowledge available, and to this end the Central Register was formed. As is well known, the Register is intended to be a complete and up-to-date record of the qualifications, experience and present employment of scientific and professional men throughout the country. There have been criticisms of the extent to which it has been used, but nevertheless it must be recognized, from the figures that have been published from time to time, that it has served a valuable purpose in filling numerous posts where the special knowledge or aptitude of scientific men has been of direct service in the war effort.

As regards the senior men of science, many of them were quickly absorbed in a number of advisory committees attached to Government departments. This was, of course, no more than a development of the peace-time practice of using scientific consultants. Advice was sought and given on specific points, but it rested with officials and Ministers, often men with little appreciation of scientific developments, to decide policy and take action. The position was somewhat better where there were influential advisory councils consisting of departmental scientific advisers and eminent men of science from outside the Government service. Some of these bodies were appointed a good many years before the War, and have given valuable guidance ; among them may be mentioned the Advisory Council of the Department of Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council and the Aeronautical Research Committee. Among the war-time bodies of this character are the Civil Defence Research Committee, serving the Ministry of Home Security, and the Council for Scientific Research and Technical Development, serving the Ministry of Supply.

Still scientific men and their representative bodies had no direct voice in the formulation of policy. This defect was to some extent remedied by the formation of the War Cabinet Scientific Advisory Committee, composed of six eminent men of science, three of whom are Government servants and the other three the president and two secretaries of the Royal Society, thus preserving a balance between departmental and outside interests. The Committee, under the chairmanship first of Lord Hankey and now of Mr. R. A. Butler, reports direct to the Cabinet. A similar body under the same chairman, the Advisory Committee on Engineering, has analogous functions.

So much for the organization of scientific effort and for the means which have been adopted to ensure that sources of scientific and technical knowledge are at the country's service. But as Sir Henry Tizard pointed out in an address to the Parliamentary and Scientific Committee early this year, there are both tactics and strategy in the application of science.

Broadly speaking, the Scientific Advisory Committee, and the Advisory Committee on Engineering, with their numerous outside contacts, can exert an influence on the strategy of science; the Central Register and various departmental committees look after recruitment and tactics.

The next step is to examine the means adopted for translating strategy into action. The crux of the matter seems to be the system whereby the administrative side of Government departments exerts a disproportionate influence on the course of events. A great improvement in departmental outlook has resulted from the appointment of strong advisory councils including independent as well as departmental scientific and technical officers. The Air Ministry had long availed itself of external scientific advice, and the Ministry of Supply—which took over the scientific functions of the War Office—did the same through its Scientific Advisory Council and committees. By such means contact with the outside scientific world was ensured for their full-time workers. The Ministry of Aircraft Production took over in 1940 the scientific functions of the Air Ministry, but Sir Henry Tizard, rector of the Imperial College of Science and Technology, is a member of the Air Council as well as of that of the Ministry of Aircraft Production, and in the War Office Sir Charles Darwin has recently been appointed scientific adviser to the Army Council.

The position in the Admiralty is not so good. The Admiralty has maintained a Scientific Research and Experiment Department for many years, but its director has not the collaboration of an advisory council containing experienced outside scientific men, and the workers in Admiralty scientific establishments are far more isolated than elsewhere. Matters are improving, for a panel was appointed a little more than a year ago, containing two external scientific members, to examine the working of Admiralty establishments; and recently a group has been appointed to conduct operational research in connexion with the Naval Staff.

Although such advisory councils have done invaluable work, there is ample evidence of continued dissatisfaction with the rate of application of scientific and technical knowledge and development in the national war effort. The Association of Scientific Workers has been investigating alleged misuse of man-power and materials, and its findings are being forwarded to the Ministries of Labour and Supply, and there have been numerous suggestions in the Press for the more efficient utilization of the excellent scientific and technical resources of the country, including a revival of the suggestion for a Ministry of Science. A vigorous letter from Prof. A. V. Hill dealing with the importance of scientific and technical guidance in the highest circles of government was published in *The Times* of July 1, and succeeding correspondence has shown that his proposals have provoked wide interest. Prof. Hill says that many of our disappointments and failures to match Axis moves in the past have been due to technical mismanagement, in the sense that there has been neglect to anticipate future requirements and to profit by operational experience. The Chiefs of Staffs organization deals with operations, the Ministry of Production deals with supply; but there is no comparable body to advise the Cabinet or the Chiefs of Staffs directly on scientific or technical aspects of either operations or supply. Such a body is necessary to guide those who are directing the strategy of the present conflict. He then describes in outline the organization which has been adopted in the United States. A year ago an office for Scientific Research and Development was established under the chairmanship of Dr. V. Bush, formerly of the Massachusetts Institute of Technology, with three departments: the National Defense Research Committee (under Dr. J. B. Conant) to deal with research and development of weapons; the National Advisory Committee on Aeronautics (under Prof. J. C. Hunsaker); and the Committee on Medical Research (under Prof. A. N. Richards). This body reports direct to the President. Recently a Joint Committee on New Weapons and Equipment, consisting of Dr. Bush (chairman), one technical staff officer from the Army and another from the Navy, has been appointed, with executive authority, to work with the American Chiefs of Staffs organization, advising on technical, engineering and scientific matters, and guiding research and development in the interests of the Fighting Services.

The formation of a small body with similar powers and similar qualifications is long overdue in Great Britain. A committee or council so constituted, with high authority and direct access to the innermost councils of the State, and including adequate independent scientific and technical opinion, would be in a position to supervise the whole range of research and development coming within its field of knowledge, and to provide the co-ordination and cohesion necessary in waging a war in which the machine element plays so large a part.

Tactics

Strategy and tactics in the application of scientific developments both fail if the individual men of science are unable, for any reason, to respond to the calls made on them. To pursue the military analogy, they must keep 'fighting fit'; their minds must be fresh, active and responsive, and their knowledge must be up to date. In normal times, scientific men working in university or similar laboratories have the continuous stimulus of contact with other men engaged in diverse work, both inside and outside their own field of study; many of them spend a certain amount of time in teaching. They are members of learned and professional bodies through which the relevant literature is made available and meetings for discussions are arranged. In short, there is every facility for maintaining contact with the progress of thought in a selected field, and also with the everyday world. Workers in industrial laboratories are perhaps not quite so fortunate, in that trade 'secrets' have to be borne in mind, and they may not feel quite so free to speak in discussions. Nevertheless, it will be conceded that industrialists in general realize that research workers must be given latitude in this matter, and they usually encourage them to keep up their scientific contacts.

Scientific men in Government service are in many cases on a very different footing. In certain laboratories and establishments, notably those working under the three research councils (Department of Scientific and Industrial Research, Medical Research Council and Agricultural Research Council), they are, for the most part, almost as unfettered as are research workers in a university. Their work is usually published through the ordinary channels, and is submitted to discussion both by their own colleagues and by outside independent scientific workers. In other departments, particularly those attached to the Fighting Services, conditions of secrecy impose restrictions. It must be recognized that many of the investigations undertaken by such departments cannot be divulged, but because this is so, it does not follow that every investigation is a sealed project, and that the unfortunate individual or individuals to whom it is allotted should retire into monastic seclusion, separating themselves from their scientific brethren. Indeed by so doing, they cut themselves off from the fertilizing influence of discussion and criticism, and the quality of their work suffers accordingly. In time of war, the position is aggravated, and there is the very real danger of the administrative element taking alarm and decreeing that all work carried out in the department is secret. The proper course is to acknowledge frankly the limitations imposed by the nature of the work, and take appropriate steps to mitigate their effect.

Scientific workers in Government departments have indeed to meet special difficulties. There is grave danger of stagnation, and senior men may easily tend to become officials rather than working men of science. It is not sufficient to have a permanent scientific staff, supplemented during war-time by leading scientific workers, together with a number of temporary juniors, and to supply them with equipment and literature; they cannot develop their powers to the full in isolation. Yet this is the position in some Government Departments. It is only a reasonable precaution, at which none will cavil, that those in Government service should be expected to obtain official permission to carry on outside scientific activities; but in practice they may be actively discouraged from maintaining their contacts with the world of science.

There have been many suggestions in the past few years for improving the lot, and the efficiency, of scientific workers in Government service. The appointment of scientific advisory councils including independent scientific men, to survey progress and development in the various Departments of State, could scarcely fail to have beneficial effects. One of the first would no doubt be diminished isolation of the scientific men, particularly the younger ones, with a resulting improvement in the quality of their services to the nation. The criticism of their colleagues plays an important part in developing and maintaining at a high level the powers of scientific workers; it is an essential part of their equipment, the importance of which increases with their responsibilities.

FORMATION OF THE GANGES DELTA

Deltaic Formation

With Special Reference to the Hydrographic Processes of the Ganges and the Brahmaputra. By Prof. C. Strickland. Pp. xvi+157. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1940.) 9*s*.

WHETHER one judges by length of sea face or by distance from the apex, the combined delta of the Ganges and Brahmaputra is the largest in the world, which gives it an importance not lessened by its density of population, and its length of known history. Consequently the appearance of a work dealing comprehensively with its mode of formation and continued modification is of importance not only to geologists, but also to engineers, administrators, and medical men, and to all others who have to deal practically with the working and changes of deltaic rivers.

Much has been written in the past on various aspects of the combined delta of these two rivers and of their history as a whole, the two most important works being James Fergusson's classic paper "On Recent Changes in the Delta of the Ganges"[1], and Chapter 17, on the "Indo-Gangetic Plain", of the second edition of Medlicott and Blanford's "Manual of the Geology of India", as revised by R. D. Oldham in 1893. Fergusson is one of those rare men who have produced classics in two branches of knowledge, the other being his "History of Indian and Eastern Architecture"; and both his classics still hold the field to the present day as the most important works in their respective spheres.

No detailed or even continuous geological survey of the Ganges-Brahmaputra delta has ever been attempted owing to the paucity of geologists in India compared with the tasks; but certain of the major aspects of the Indo-Gangetic river system including the deltas have been dealt with by geologists, while some of the more detailed aspects of the Ganges-Brahmaputra delta have been discussed from time to time by settlement officers, and by engineers concerned with irrigation, drainage and river training; further, of recent years, gravity observations by the Geodetic Branch of the Survey of India, and by the staff of the Burmah Oil Company, have led to the acquisition of knowledge, not all of it published, concerning the configuration of the basement upon which the delta rests.

It is timely, therefore, that some one should attempt to synthesize the growing knowledge on this delta, especially one who has had abundant opportunity to make personal observations on the behaviour of rivers in deltaic tracts as an adjunct to his own professional work. For Dr. C. Strickland, who is a member of the professorial staff of the School of Tropical Medicine, Calcutta, has had occasion, in his medical capacity as a research worker on problems connected with the causes and prevention of malaria, to travel far and wide, not only in Bengal and Assam, but also in Burma and Malaya, and elsewhere; like Fergusson he has made full use of his opportunities to observe the detailed behaviour of deltaic rivers.

In his book the author devotes the first twenty-six chapters to the discussion of the hydrographic processes at work in the Ganges and Brahmaputra, assuming the rock basement on which the alluvium rests to be static, and reserving for a final chapter "the influence of diastrophism of the earth's crust on the hydrographic processes". The author has recognized the important geologist's separation of the alluvial deposits into 'older alluvium' and 'newer alluvium', the older alluvium being now subject to denudation and the newer alluvium still in course of deposition, either in channels in the older alluvium or on land newly won from the sea; but he prefers to describe these respectively as 'paradeltaic' and 'deltaic' deposits. This has really involved a redefinition of the term 'delta', and leads to the confusing result that patches and streaks of 'paradelta' may be mixed up with or surrounded by the 'delta', while strips of 'paradelta' are found right into the Himalaya. To me it seems preferable to retain the customary use of the word 'delta', recalling that it takes its name from the triangular shape of the Greek capital letter, and that a delta commences at the point where a river begins to divide into distributaries, this point being the apex of the delta. The deltaic tract, on this usage, then consists of portions that were formed in the past and may now be undergoing erosion, and portions where active deposition is still taking place. However, Dr. Strickland's use of the term 'paradelta' does not spoil comprehension of his work. If adjectives are required to describe the older and newer deltaic deposits, would not *palæodeltaic* and *neodeltaic* be suitable?

The main thesis of this book is that all the changes observed in a delta can be explained purely on a hydrographic basis without invoking the aid of diastrophic processes. Thus the fact that there is a belt of low-lying land occupied by numerous swamps, with *bhils* or *jhils* of water, stretching continuously from near Calcutta eastwards through the districts of Jessore, Faridpur and Backergunge, as indicated on Fergusson's map, and separated from the sea face to the south by a belt of higher land, is not, according to Dr. Strickland, due to a diastrophic depression of the swamp belt, as some engineers and settlement officers have urged, but to the elevation of the seaward belt by deposition from the distributaries of the delta, as is accepted by geologists. Also Dr. Strickland holds that such elevated tracts as the well-known Madhupur Jungle north of Dacca are merely residua of denudation and do not owe their existence to tectonic uplift. In this he disagrees with Fergusson and Oldham, and is perhaps unaware that Colonel Glennie, of the Survey of India, has recently shown by means of gravity determinations that there is a minor 'up-warp' under the Madhupur Jungle.

Dr. Strickland is working on sound lines in explaining as much as he can on a purely hydrographic basis, drawing his deductions from phenomena that are observable at the surface; but it must be recalled that the deltaic tract of the Ganges and Brahmaputra is tectonically very unstable, as is shown by the frequency of earthquakes, which in some cases, especially towards Assam, have produced results observable at the surface, as described in the relevant Memoirs of the Geological Survey of India.

Moreover, while anyone who studies the geological and orographic data can accept the view that the Brahmaputra and Ganges were once parts of a river flowing westwards to join the Indus system (Pascoe's "Indobrahm" and Pilgrim's "Siwalik River") and separated from the Bay of Bengal by a ridge of land joining the north-east corner of the Peninsula to the Assam Plateau; and that this ridge has since been breached, so that a southward-flowing river or rivers (for example, the ancestor of the Bhagirathi and Hooghly) debouching into the Bay of Bengal could cut back by head erosion and tap the Indobrahm, it does not follow that this was achieved by head erosion alone. It seems to me that diastrophic processes must also have taken a hand, and that this breach through which the Ganges and Brahmaputra now flow south is partly the result of down-faulting. According to the gravity results of the Survey of India[2] there is still an axis of 'up-warp' (by which is presumably meant a belt of rock denser than that to the north and south) connecting Bihar and Assam under the Ganges-Brahmaputra alluvium. As the back of this axis of rock, however shallow the alluvium may there be, lies presumably below sea-level it cannot have been lowered by river erosion, and must have been thrown down by tectonic movement.

Further, as the alluvium under Calcutta is known from borings to be at least 1,306 ft. deep[3] (and is possibly several thousand feet thick), and is composed of freshwater and estuarine sediments that were all deposited at or close to sea-level, the rock floor beneath the Ganges delta must have sunk by 1,300 or more feet, due either to the growing load of sediment (then an isostatic adjustment), or to direct diastrophic movement; consequently it is impossible to exclude causes other than hydrographic from the general discussion, although all surface details can be explained in terms of deposition and erosion due to hydrographic processes, as is done so lucidly by Dr. Strickland. Once the necessity of admitting the action of diastrophic processes at least at intervals is recognized, one must admit also the possibility that the Madhupur Jungle and other elevated tracts of older alluvium owe their present elevation to uplift.

Every student of river processes is recommended to study Dr. Strickland's work, wherein he will find a full discussion of the processes by which new land is won from the sea, of the formation of lagoons or *bhils* of various types and of islands (*dwips*), of the embankment of rivers, of the conflict between the transporting action of rivers and the influence of tidal waters, and of the gradual death of many deltaic river channels. In reading this book, however, he will find it necessary to make periodic reference to a dictionary, because the author uses many uncommon words, or gives them unusual meanings, such as "appose" and its derivatives, "occlude" and its derivatives, "declivity", and "infinitesimally great"; or uses words that do not appear to have dictionary sanction, such as "alluviation", "diluviation", "siltation"; while the word "height" is consistently spelt with a final "h". But these difficulties are alleviated (or shall we say "alluviated"?) by a racy style and free use of happy metaphor, as in the following quotation, which illustrates the spirit of the book (p. 4): "Therefore no alluvial deposit has any 'divine right' to permanency, simply because it was once thrown down by a 'wet nurse' who could bear the burden no longer."

L. L. FERMOR.

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[1] *Quart. J. Geol. Soc.*, **19**, 321–54 (1863).

[2] Geodetic Report, Survey of India 1937, Chart IX.

[3] See Dr. A. L. Coulson's "The Geology and Underground Water-Supply of Calcutta, Bengal, with special reference to Tube-Wells", *Mem. Geol. Surv. Ind.*, **76**, 24 (1940). This work is contemporary with Dr. Strickland's book, and neither author appears to be aware of the other's work. Chapter 2 of Dr. Coulson's memoir gives an excellent summary of previous work on the "Early History of the Ganges and the Formation of the Ganges Delta".

A PHILOSOPHY OF THE UNIVERSE

Design and Purpose

By Prof. Frederic Wood Jones. Pp. 84. (London: Kegan Paul and Co., Ltd., 1942.) 5*s.* net.

IN this little book, an expanded version of his Purser Lecture at Trinity College, Dublin, Prof. Wood Jones expresses his general philosophical convictions. The whole universe, he argues, forms one system, a chain of being including both the animate and the inanimate. Man has his place in the system along with all other creatures and is in no way apart from or above it. The system is not to be considered as a mechanical aggregate but as exhibiting design throughout and as the sphere of purposive action; as, in fact, the outcome of the creative purpose of the cosmic mind. The author invokes, in support of his view, the animism attributed to primitive man, the systems of Buddha and Lao Tze, and also of Plato and Aristotle—rather a mixed bag of authorities.

What is more surprising is that Prof. Wood Jones also invokes the support of Paley. For Paley surely, like practically all those of his time, was arguing for a purely mechanical universe in which living organisms were just more elaborate and automatic machinery, and all was designed and run by the Great Artificer. It may be granted at once that Paley was more clear-sighted than many of the Darwinians of a later day who supposed that automatic machinery could somehow design, produce and run itself by pure luck, coupled with the blessed word 'evolution'. Still Paley stands for two doctrines that are otherwise anathema to Prof. Wood Jones. As to the first, Paley's system was not conceived in terms of a theory of pantheism or of a purely immanent world spirit, such as Prof. Wood Jones approves, but in terms of a personal and transcendent deity. That is a view that Prof. Wood Jones attacks fiercely, seeing nothing in it but an unfortunate survival of the tribal god of the ancient Hebrews. Clearly you can have either a mechanical world run by a transcendent mechanic or the world as organism animated by a world soul. By itself each is a reasonable view, but the two are not easy to reconcile; certainly the advocate of one can scarcely claim the support of the advocate of the other.

The second difference is that Paley, necessarily as a Christian, held that the human soul is in some way separate, distinct from and above the material and mechanical world. Plato also held this view, though he did not believe in a mechanical universe. For Prof. Wood Jones such a theory savours of false pretensions and arrogance. There is a very dangerous kind of humanism which puts man above Nature, and it has been very prevalent since the Renaissance. Against this his attack is well and properly directed, but it has nothing to do with Christian or Platonic theories about the soul, which are perfectly compatible with his view, and which I believe he misunderstands. His point may be put quite simply. Analytic, sophisticated urban thinkers tend to imagine man as something separate from his environment, superior to it and therefore entitled to interfere with other creatures to make them serve his own ends. A true appreciation of the facts comes easily to man living under primitive conditions. The facts were clearly seen by synthetically minded thinkers of earlier times. The same lesson can, however, be equally well learnt from biological science when the view of the whole is not obscured by partial views of mere specialists. If we realize that organism and environment are inseparable and each adapted to the other, that men like all other creatures have a part to play in a cosmic purpose greater than any individual, then we are likely to take a humbler and more balanced view of ourselves. This is worth saying. In this connexion Prof. Wood Jones does well to remind us of Samuel Butler, even though Butler's biology was not always very sound. It is true that science in the strict sense can tell us nothing about a cosmic (or any other) purpose; it is a metaphysical notion. It is also true that if there is no kind of cosmic purpose, then the purposes of individual human beings are futile.

A. D. RITCHIE.

ECONOMIC FORCES AND WORLD ORDER

The Economics of 1960

By Colin Clark. Pp. x+118. (London: Macmillan and Co., Ltd., 1942.) 8*s.* 6*d.* net.

MR. COLIN CLARK is easily the most daring of statisticians. We have known since he published his "Conditions of Economic Progress" that there is almost no degree of inadequacy in the data that is enough to deter him from arriving at some sort of a quantitative conclusion, however provisional it has to be. In his new book he applies to the future the methods he has made his own in handling the present and the past. His general thesis is that the course of economic development over the next two decades will probably be affected very little by political events. War may retard the processes of growth, but will scarcely alter their character; and changes in social system and class structure can also be disregarded in measuring the probable movements of the world's economic life. In the past, Mr. Clark maintains, wars and revolutions have been unable to override fundamental economic forces; and we and our children are likely to find it so again.

To be sure, Mr. Clark postulates, for the purpose of his prophecies, a world not dominated by economic nationalism, and a freedom for the exchange of commodities and services in marked contrast to the tendencies of the past twenty years. But he seems to think that this freedom will be forced on the world by economic forces, whatever politicians may plan. His thesis is that historically economic development reveals an alternation of 'capital-sated' and 'capital-hungry' periods, and that, after a period of satiety, the world is due to pass into a period of capital-hunger which will be intensified by war-destruction. He therefore looks forward to a very active resumption of international investment, accompanied by, and indeed involving, a big shift away from primary production to manufacturing and service industries, as well as a sharp alteration in the 'terms of trade' in favour of primary producers as against manufacturers.

These shifts, he believes, will be part of a process which will add immensely to the world's total wealth and especially to the productivity and income of the countries which are behindhand in economic development. He expects China, India, Eastern Europe and other backward areas to absorb huge masses of capital and, while becoming industrialized, to become at the same time greatly improved markets for the consumers' goods as well as for the capital goods of the already developed countries. He expects not only the United States, but also the U.S.S.R., to become a large net importer of foodstuffs and other agricultural products, and advances notions which are at first sight startling about the economic future of many other areas. His arguments are backed up by the clear demonstration that the immense changes which he confidently predicts are no bigger than the changes which actually occurred during the nineteenth century under the impact of the Industrial Revolution.

A large part of Mr. Clark's book is statistical; and many of his calculations refer back to his "Conditions of Economic Progress", and cannot be fully understood without looking up the relevant passages of that work. Indeed, "The Economics of 1960" is in form a sort of forward-looking postscript to his "Conditions"; and critics who were sceptical of Mr. Clark's methods in the main book are likely to be no less sceptical now. I confess, myself, to a certain degree of scepticism, combined with a conviction that Mr. Clark is essentially right. I do not believe in many of his figures; but I do believe that he is correctly predicting the trends, if not their absolute or relative strength. There can be no doubt either that the world is ripe for a vast new adventure in international capital development, based mainly on the rapid industrialization of Eastern Europe, Asia, and parts of Africa, or that this new phase of growth requires a politico-economic setting of unrestricted, though not necessarily unregulated, foreign trade. If the political settlement after the War is of such a character as to frustrate the exchange of goods and services, there will be a terrific conflict between the forces sustaining the settlement and the forces making for a world crusade against poverty and unemployment. Mr. Clark seems to be entirely confident that in this struggle the forces of unreason would get the worst of it. I sincerely hope they would; but I am not so sure—and I am still less sure that the basic economic forces will win quickly enough for all the gains Mr. Clark has in mind to have been safely garnered by 1960.

I am therefore disposed to accept this statistical pamphlet less as an essay in prophecy than as a pointer towards a sane world economic policy. For I think Mr. Clark has been able to show quite conclusively that the world can, if it behaves itself with ordinary common sense, be by 1960 immensely more prosperous than it has ever been, and that too with a prosperity shared in by most of the human race. Regarded in this way, Mr. Clark is a powerful ally of Mr. Roosevelt, Mr. Wallace, and other American spokesmen of the age of plenty, and a formidable critic of the economic restrictionism which has been so terrifyingly enshrined in recent pronouncements of the Federation of British Industries and other representative organizations of British capitalism. Certainly, if these apostles of monopoly get their way, Mr. Clark's predictions will not be verified. Rational division of labour between areas will be prevented; international investment will not revive; there will be mass-unemployment as there was in the 'thirties, and probably yet more and more devastating war. Mr. Clark, I think, will agree to this, but will reply, more confidently than I can, that the restrictionists will not get their way, and that, war or no war, the underlying forces making for economic progress will get theirs. I am not so sure as he is that our civilization is indestructible by human folly. But I earnestly hope that he is right; and I welcome his book as a most cogent dramatization of what mankind is in a position to accomplish in the economic sphere, if mankind but will. G. D. H. Cole.

A POPULAR INDEX TO COLOUR

Horticultural Colour Chart

Vol. 2. Issued by the British Colour Council in collaboration with the Royal Horticultural Society. 100 plates. (London: Royal Horticultural Society, 1942.) 12*s.* 6*d.* to Fellows of the Society; 22*s.* to non-Fellows.

An abnormal three years have intervened between the publication of the first volume of the Horticultural Colour Chart (reviewed in Nature of March 11, 1939) and the recent appearance of the second volume, and the publishers are to be congratulated on the foresight which led them to reserve the art paper and other materials required to ensure uniformity of make-up.

Thirty-four of the new sheets show lighter tints, twenty-eight selected darker shades, and the remaining thirty-eight plates are taken up with hues greyed to a lesser or greater degree. (Twenty-six sheets of the first volume represented paler tints, and ten darker shades, of certain of the sixty-four full hues.) The extent to which the brightness or purity of the full hue is modified is indicated by an appropriate prefix to the sheet reference number of the unmodified colour. A complete series on these lines would require a great number of sheets, and convenience and cost alike demand a reduction to more manageable proportions by selection of the most useful modified or supplementary colours. The publishers imply, although they do not specifically state, that this second volume is final.

A random selection of flowers picked during March–June showed the chart as a whole quite efficient in providing close colour matches. It fails in some cases. Many Polyanthus have flowers outside its range, particularly in dark shades; Viola and other genera, including dark and velvety-textured flowers, discover the same lack of matching sheets. The bluest primroses would require the appropriate hues to be twice or thriced greyed in the scheme of the chart, whereas they are only represented once greyed, if at all. By a process of imaginative intercalation or extension such gaps can be filled, and a non-existent sheet number quoted as a guide to the required colour, if not as a certain match. Browns are ill-represented. This weakness is perhaps not important where flower colour is concerned, although it will be noticed, for example, in connexion with Fritillaria; but greater curtailment of the usefulness of the chart in other spheres will result.

The "horticultural examples" given on the sheets are not always happily chosen. The flowers of *Aquilegia vulgaris* as a wild plant vary considerably in hue, and in the garden show a whole gamut of colours of which the "aconite violet" singled out for quotation is doubtfully the commonest. Similarly injudicious references are *Saxifraga oppositifolia*, *Primula denticulata*, *Dianthus barbatus*, and *Geranium sanguineum.*

The most serious faults of the chart were already obvious in the first volume. There is considerable but inconstant overlap between tones of the same hue on different sheets; 928, for example, appears quite redundant, as 828 and 1028 form a continuous series without appreciable break; the range of colour on 403, 503 and 603 could comfortably be accommodated on a single sheet. If this kind of duplication had been avoided the same number of two hundred plates could have covered most of the omissions mentioned above.

A common lilac (*Syringa vulgaris*) is placeable with equal propriety against 437 or 537/2; but its colour would accordingly require naming pastel lilac or (pale) mauvette. In the same way *Scilla bifolia* may be (pale) gentian blue or flax blue. Quite apart from the alternative classifications made possible in this way, unrelated colour names within the confines of a single hue are a mistake. If independent names had been restricted to the sixty-four full hues (relaxing this rule in favour of brown and pure grey), and, to take a set at random, sheets 622, 22, 022, 0022, 722, 822 had been named pale crimson (or crimson pink), crimson, dull crimson, grey crimson, rich crimson, deep crimson, instead of camellia rose, crimson, rose opal, rhodonite red, cherry and cardinal red, not only would relationships have been made obvious, and despite overlapping, serious ambiguity avoided, but also actual use of colour names in a uniform sense would have received far more encouragement than will be given by the chart in its present form. Utility has been sacrificed on the altar of 'historical interest', and the best possible use not made of good work.

For the chart itself is good work. Perfection has not been attained, of course; the tone intervals are not constant in the treatment of different hues, and changes in intensity (purity or saturation) occur where nominally only a tone difference exists. But obvious fault is very rare, and the ink makers and printers are to be congratulated on a fine technical achievement.

SAMPSON CLAY.

SOME ASPECTS OF PHYSICS

Reports on Progress in Physics

Vol. 8 (1941). General Editor: W. B. Mann. Pp. iv+372. (London: The Physical Society, 1942.) 25*s*. net.

THE years since the outbreak of war have seen an unprecedented increase in the number of men actively engaged on research in physics, using the word 'research' in the sense of the application of the principles of physics to the solution of urgent practical problems. New research establishments have been created, old ones greatly extended, and students are being rushed through universities and technical institutions to give a hand with the work, or to service the inventions which have already reached the stage of production. That this expenditure of energy and ingenuity is not going unrewarded is well known, though, for obvious reasons, nothing of this activity can yet find its way into "Reports on Progress in Physics", the eighth volume of which (1941) is now to hand. When the time comes to raise the veil of secrecy which now necessarily hides the war-time activities of physicists from the common gaze, the editor of these Reports will be in for a good time: for it can scarcely be doubted that much of permanent interest will emerge from these *ad hoc* investigations. In the meantime he undoubtedly has his troubles. Not only has fundamental research been replaced by war-time activities, but also likely authors are too preoccupied to report even on immediate pre-war discoveries. That, in the circumstances, the new volume should have appeared so promptly, and, in appearance and format so like its elegant predecessors is an achievement on which the Physical Society, and the new general editor, Dr. W. B. Mann, may be sincerely congratulated. That, in addition, it should contain three or four reports of real interest is an uncovenanted mercy for which we may be duly thankful.

For this admirable result the editor is much indebted to the generous help of American physicists, who have contributed more than half the text, and considerably more than half the interest of the volume. At the time when the reports were planned the shadow of war had not actually engulfed the United States, though it was obviously approaching fast. Physicists there had just time for one further look round the laboratory before taking off their coats and settling down to the job; and they have certainly made the most of the opportunity. That they should, as the editor records, have also requested that the honoraria attached to the reports should be given to some suitable fund in Great Britain is only one further example of the large-hearted sympathy which American men of science have so consistently shown towards us throughout our struggle. We shall not easily forget it.

To present a completely impartial account of a collection of fourteen separate reports on a wide variety of topics is probably beyond the power of a human physicist; no doubt some ingenious combination of photo-cells and electronic valves will ultimately be designed to do the job. In the meantime judgment is certainly influenced by personal interest in the subject-matter of the report. In particular, a wide and ever-widening chasm seems to be opening up between the experimental and the theoretical physicist. Much as we may agree with Prof. Born (whose article on the "Teaching of Theoretical Physics" opens the volume) that "the separation of one single science, physics, into two parts which differ, not with respect to the object but with respect to the method" is particularly regrettable, it must be confessed that neither party is much interested in the other's technique, and that neither the language nor the modes of thought of the theoretical physicist are easily comprehended by his experimental colleagues. To ask that the theoretical physicist should write for the benefit of the experimentalist would be to deprive his report of much of its intrinsic value. A subject which, to quote Prof. Born again, requires only "paper, ink, pen, a few books, and a calculating machine" is likely to be popular in the days of austerity after the War; unless, of course, one of the 'planning' committees for which some of our enthusiasts are pressing should decide that the subject is anti-social, and order its suppression. May we offer the suggestion that, when times become easier, the Physical Society might consider the possibility of issuing separate Progress Reports on the two aspects of our vast subject; employing some specially gifted person—Prof. G. Gamow could do it—to report to the experimental physicist as much as he needed to know of the contents of the theoretical volume.

Descending from the general to the particular, every physicist will be glad to have at hand Raymond T. Birge's latest report on the "General Physical Constants", and the tabular results of his latest survey of this fundamentally important subject. Incidentally we may hope that the powers that be (if there be any "powers" in physics) will take note of the fact that, owing to the coexistence of international coulombs, absolute coulombs, a chemical scale of atomic weights and a physical scale of atomic weights, Birge finds it necessary to give four different values for the Faraday constant, and decide to do something about it. George R. Harrison gives a fascinating account of the M.I.T. project for measuring and tabulating the wave-lengths of some million spectrum lines—an example of mass production in high accuracy measurement which in ingenuity and courage can bear comparison with anything achieved in industrial mass-production. J. W. Beams contributes a useful summary of advances in "High-speed Centrifuging"; and "Recent Television Developments" are dealt with by V. K. Zworykin and R. E. Shelby, of the R.C.A. and the National Broadcasting Company, New York. On the theoretical side, Robert S. Mulliken and Carol A. Rieke report on "Molecular Electronic Spectra", and Eugene P. Wigner and Eugene Feenberg discuss the "Symmetry Properties of Nuclear Levels".

It would be unreasonable to expect that all the reports in the volume should reach the level of interest of those named in the previous paragraph. R. W. Lunt, with von Engel and J. M. Meek, gives a useful summary of the present position as regards discharge phenomena in gases, leaving one with the no doubt justifiable impression that there is still a good deal to be cleared up in the subject, and A. Hunter contributes a readable account of recent improvements in instrumental technique in astrophysics. If some of the remaining contributions scarcely seem to come up to pre-war standards (and it must be admitted that one or two of them are a little weak) we must lay the blame on the times. "Reports on Progress in Physics" has established itself as the most important yearly publication in the subject. In spite of difficulties, the present volume as a whole does nothing to impair its reputation. May we wish the Society and the editor equal good fortune with Volume 9. J. A. Crowther.

A FATEFUL LEGACY

Darwin, Marx, Wagner

Critique of a Heritage. By Jacques Barzun. Pp. xii+420. (London: Martin Secker and Warburg, Ltd., 1942.) 15s. net.

Mr. Barzun is a historian who is especially interested in the political effects of theories of race and class conflicts. He has already published works on "The French Race" (1932), "Race: A Study in Modern Superstition" (1937), and "Human Freedom" (1939). His researches have convinced him that the terrible predicament in which mankind now finds itself is mainly the result of the influence of certain ideas set in motion by three men in the second half of the nineteenth century—including under 'influence' also reactions against them. The three thinkers in question were Darwin, Marx and Wagner. At first sight this may seem a curious combination. The author may appear to have been impressed unduly by his observation that it was in the same year (1859) that Darwin published "The Origin of Species", Marx his "Critique of Political Economy", and Wagner completed "Tristan and Isolde". Whether this was or was not a mere coincidence, Mr. Barzun makes out a plausible case for his view that, in spite of their obvious differences, the three authors expressed and popularized one and the same philosophy, namely, that of mechanistic materialism. Darwin did so in the field of natural science, Marx in that of sociology, Wagner in that of art.

The possibility of a common world view, amid their divergent specialisms, was facilitated by the fact that none of the three men stuck strictly to his last; they all spread themselves more or less widely beyond their special province. Darwin had much to say about psychology and social science; Marx exercised the privilege of a philosopher, and took all the world to task; Wagner wrote more than he composed—in fact his writings fill ten volumes, and deal with all sorts of things.

Mr. Barzun also detects some common traits in the characters of the three men. He contends that they were all rather self-centred, ungrateful to their forerunners, and ruthless to their rivals and critics. Many who would readily agree with this view of Marx and Wagner will probably demur in the case of "our gentle Darwin". Mr. Barzun, however, submits a considerable amount of evidence in support of his contention. Some of the evidence may be indicated briefly. Darwin somehow conveyed the impression that he had arrived at his conception of evolution independently of his predecessors and contemporaries, although it is known that he was acquainted with the work of Buffon, Lamarck, Malthus, and his grandfather Erasmus Darwin. The "Historical Sketch", which was first added to the third edition of "The Origin of Species", dismisses Buffon, misrepresents Lamarck, and buries Erasmus Darwin in a footnote. Yet, according to Osborn, Darwin's theory of the origin of species was really threefold, and two of these component theories were adopted from Buffon and Lamarck.

Be this as it may, Darwin's main contribution to the theory of evolution was, of course, his theory of natural selection from accidental variations. Variations favouring survival are preserved. But the variations are accidental, and the selection is natural or automatic. So the changes in living forms appear to be accounted for in a more or less mechanical way. Nature red in tooth and claw did not disgust Darwin. He could even see grandeur in this struggle for existence. "From the war of nature," he wrote, "from famine and death, the most exalted object of which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life." It was obviously easy to misapply such a view to politics. People saw grandeur in war and other forms of political and social conflict. The literature of the period 1870–1914 is one long call for blood. In almost every European country during that period there was a war party demanding armaments, an individualist party demanding ruthless competition, an imperialist party demanding a free hand over backward peoples, a socialist party demanding power, and a racialist or nationalist party demanding purges of aliens. Of course, Darwin would not have approved of such applications of his view. In fact, he soon began to have doubts about the efficacy of natural selection even among races of pigeons, let alone races of men. But ideas once set in motion soon get out of the control of the originator, and continue to be misapplied by unscrupulous opportunists in ways that sometimes make science a source of mortal danger to mankind.

Marx regarded himself as the Darwin of sociology.

He wanted to dedicate his "Capital" to Darwin, who, however, declined the honour without interest. Social development appeared to Marx to be essentially similar to natural evolution. Both are determined by material factors; and the individual does not count in either case, only the class. The material factors in the case of the social group are the natural resources, modes of manufacture, means of communication, etc., which constitute the social environment; and the social struggle for existence takes the form of a conflict of classes, through which progress is achieved. Marx, however, was not content to leave things to 'natural selection'. He resorted to fierce propaganda, fanatical agitation, and ended as the "Machiavelli of the working class movement".

Of the three characters who occupy Mr. Barzun's stage, Wagner was undoubtedly the most mischievous. He was selfish and opportunist in the highest degree; and as a born actor he managed to appear better and wiser than he was. His music-dramas, like his life, are mainly concerned with fighting, deception and adultery; and his use of old pagan legends and a creed of fatalism was a device to put at least a thin veneer of respectability on the immoral. Nietzche saw through him and denounced him. The militarists, however, found in Wagner just what they wanted, especially in his "Ring", which celebrates the superman and the triumph of Germanism, in a tale of blood, lust, and deceit. Wagnerism became a widespread cult. German soldiers and politicians fancied themselves bestriding this world like the legendary gods and heroes of Wagner's stage. They were intoxicated by Wagner's art and his artfulness, and were stimulated in the pursuit of ambitions which for the second time in a generation are threatening to devastate mankind.

Mr. Barzun's book is not entirely free from mistakes or from an occasional tendency to journalism; but it contains a vivacious and competent discussion of many interesting problems, and may be recommended to all who are interested in our heritage of fateful ideas. A. Wolf.

ENGINEERING PEDAGOGY

Engineering Mechanics

By Prof. S. Timoshenko and Prof. D. H. Young. Second edition. Pp. xiv+523. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 28*s*.

Engineering Kinematics

By Prof. Alvin Sloane. Pp. xi+310. (New York: The Macmillan Company, 1941.) 17*s*. net.

In the training of the young engineer the teacher has to look both backwards and forwards. He has to examine carefully what has been done in the past, that his students may master the detailed technique already applied successfully in these problems. In this respect he seeks to produce young men capable of dealing with issues similar to those previously solved. On the other hand, he knows that every problem is in reality a new problem with characteristics that are different from those previously encountered. For this purpose facility with technique may not in itself suffice. What may be required is a new application of fundamentals, or a search for new generalizations from the past, to be applied in a new way.

Text-books on mechanics and kinematics therefore have two functions to fulfil. They require to present a detailed course primarily designed for improving the facility of the student in solving problems of an orthodox nature; or they may provide a reorganization of existing knowledge in new ways to throw up the underlying new principles to be found applicable to the future.

These two books, each in its own way and in its own field, deal with these separate issues. Profs. Timoshenko and Young, in this the second edition of their "Engineering Mechanics", have produced a first-rate text-book covering all the elements of statics and dynamics that fall within the scope of an orthodox set of courses—the principles of statics, concurrent and parallel forces in a plane, forces in space, virtual displacements, applications of Newton's Laws of Motion to particles and to rigid bodies, including some treatment of the gyroscope.

The illustrations throughout, although in the academic form usually associated with university courses, keep close to engineering practice. They are exhaustive, covering in each section almost every type of problem that arises, while a multitude of diagrams, clearly produced, serve to ease the development for the student. There are approximately 600 examples, many of them worked out in detail. Any student who has worked through this book will have received such a grounding in the application of orthodox dynamical principles that he will find no difficulty with the more specifically engineering problems that arise in other parts of his course. The book is excellently produced.

The other line of approach to which we have referred is stressed in Prof. Sloane's treatment of engineering kinematics. While the general headings are simple and straightforward—the rigid body, vectors, motion, displacement, velocity and acceleration—throughout the work there runs an underlying philosophical current to the book, and the fundamental concepts are critically examined and developed in a way that must be attractive and interesting to the student. Naturally a great deal of its scope is covered or implied by the previous book by Timoshenko and Young, but there is a great advantage to the budding engineer in his understanding of the principles of mechanism in being forced to study the classifications into which the multitude of mechanical devices can be subsumed. Definitions that seek to distinguish between mechanisms, machines, and instruments, for example, and so enable the wide variety of gears, cams, and linkages to be classified for their similarities and their differences, enable the author to bring out law and order throughout the whole of his text where otherwise diversity only tends to be seen. The simple headings of his chapters, already referred to, side by side with the many diverse types of illustration that fall within these heads, serve to underline this point.

It will be seen, therefore, that the particular virtue of this book lies not so much in the choice of material from the field usually covered in courses on mechanism, but rather in the pedagogical method of approach which fosters an appreciation of the common kinematical background. Like the previous book, the publishers are to be congratulated on their excellent production in paper, printing and diagrams.

Motor Vehicles and their Engines

Fifth edition, by Norman G. Shidle and Thomas A. Bissell, with the assistance of Tench Francis. Pp. vii+339. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1941.) 16*s*. net.

FOR the student who is interested in learning to do practical repair work on motor-vehicles, the first consideration is that he should obtain a comprehensive knowledge of the construction of the vehicle and its engine and equipment, and also of the principles which have governed its design. Formulæ and calculations are of secondary importance, as the repairer's work is the readjustment or renewal of parts which have gone out of order in service.

This book is designed for the student entering upon the subject for the first time, and is equally valuable for the owner-driver who wishes to take a close practical interest in his car or the transport manager whose duty it is to be familiar with the details of the fleet of vehicles under his supervision. Although it deals with current American practice, it is none the less useful in Great Britain on that account, as the main features of design are well standardized. The descriptions and explanations are given in terms which will present no difficulty to any class of reader; technicalities have been reduced to a minimum and fundamentals are stressed in the simplest possible manner.

In each section of the work, a sufficient outline of the fundamental theory is given, and special mention may be made of the way in which the electrical equipment is introduced by a statement of the theory of magnetism and electricity. Then follows the descriptive and explanatory text relating to the parts under discussion, and this generally terminates with a description of the mechanical troubles most likely to occur. In this way the student is led directly from theory and construction to the actual contacts, whether formal or informal, which he will make with the problems of maintenance and repair, and prepare him for the best use of the instruction handbook issued with each vehicle. J. A. C.

Bibliographia Primatologica

A Classified Bibliography of Primates other than Man. Part 1: Anatomy, Embryology and Quantitative Morphology; Physiology, Pharmacology and Psychobiology; Primate Phylogeny and Miscellanea. By Theodore C. Ruch. (Historical Library, Yale Medical Library, Publication No. 4.) Pp. xxvii+241. (Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1941.) 8.50 dollars.

THE scope of Dr. Ruch's bibliography is fully indicated by its title. It makes available, both to laboratory workers and to others who are interested in the subject, a comprehensive list of published papers on the anatomy, physiology, pharmacology and psychobiology of monkeys and apes.

The anatomical section deals first with embryology and general morphology, and then with the various systems of the body. The physiological and pharmacological papers are also classified primarily according to the body systems, while the section on psychobiology is organized by broad subject headings. The further subdivision of the various sections is excellent, and it is a simple matter to find whether or not papers have been published on any aspect of the primates. There is considerable cross reference, and there is an index of authors which includes some two thousand names. A very large number of individual papers are cited. The abbreviation of journal titles is according to the World List of Scientific Periodicals.

Dr. Ruch deserves the warmest thanks of students of the primates for having successfully undertaken a most laborious and painstaking task. "Bibliographia Primatologica" represents both a great public-spirited achievement and a monument to what is already known about man's closest relatives in the animal world. His work will lighten the effort not only of research workers already engaged in this field of study, but also of recruits to the subject.

Thermionic Valve Circuits

By Dr. Emrys Williams. Pp. viii+174. (London Sir Isaac Pitman and Sons, Ltd., 1942.) 12*s*. 6*d*. net.

BASED upon the lecturing experience of the author, this book presents an outline of the theory of the operation and design of thermionic valve circuits in a form suitable for university students during the final year of their degree course in electrical engineering. The treatment is confined to a consideration of the principles of the use of valves in their various forms in radio transmitters and receivers, and no attempt is made to describe how the different functions are realized in practice. While it is assumed that the reader has a knowledge of alternating current theory and the associated mathematics, a short summary of the vector algebra required for this subject is given in the first chapter. Subsequent chapters deal with the valve, and its use as an amplifier, oscillator, detector, frequency changer and modulator. The treatment throughout the book is very clear and straightforward, and appears to be almost entirely free from errors or misprints.

While there are one or two places in which the descriptive matter might have been expanded, the author has probably been wise in keeping brevity before him as one of his main objectives. Certainly the modern, hard-pressed university student will appreciate this in a book which is admirably suited to his purpose.

The Cathode Ray Tube and its Applications

By G. Parr. Second edition. (First published under the title "The Low Voltage Cathode Ray Tube".) Pp. viii+180. (London: Chapman and Hall, Ltd., 1941.) 13*s*. 6*d*. net.

THIS book was first published in 1937 under the title "The Low Voltage Cathode Ray Tube", which was somewhat misleading in view of the fact that it deals with the various forms of cathode ray tube operating at accelerating potentials up to about 5,000 volts. The first three chapters deal with construction and operation of cathode ray tubes, their focusing arrangements and the interpretation of the patterns traced on the screen for various currents or voltages applied to the deflecting system. After two chapters devoted to time base circuit arrangements, the remaining chapters deal with the application of the tubes to various radio engineering, including television, and industrial uses. The book concludes with an appendix on photography and a most valuable classified bibliography of the subject.

The publishers are to be congratulated on the general production of this book, especially on making it much slimmer by the simple expedient of halving the thickness of the paper. The book should prove most useful to all those—and they are very many indeed just now—whose duties bring them very frequently into contact with cathode ray tubes.

PHYSICISTS AFTER THE WAR*

By SIR LAWRENCE BRAGG, O.B.E., F.R.S.
Cavendish Laboratory, Cambridge

WHILE scientific men of all kinds have been called upon to use their skill and knowledge for the nation's service in the present War, certain classes have been in especial demand, and the physicist is ranked among these 'scarcity categories'. The demand for physicists exceeds the supply, and universities have been pressed to train as many men as possible to fill the gap. There was no such general demand for the services of scientists in the War of 1914–18. Although there were some technical applications which called for trained scientific men, in the main that war was fought with comparatively simple gear. Physicists are now being used to develop and use all the lighter apparatus of war, the instruments for communication, for detection of aircraft and submarines, and for direction of our batteries. They are increasingly applying their analytical technique to operational research into the most effective way of using our weapons. Many of these latest developments are directed by men supplied by our industrial or university laboratories.

Physicists in general have been drawn into the service of the country in a way that has never happened before, and for the university scientist in particular this has meant a change of outlook and of occupation of a very revolutionary kind. In peacetime, the pure scientist, as contrasted with the applied scientist, works in a world of his own, not because he is an unpractical dreamer, as is often supposed, but for a very different reason. He is generally carrying out his particular task, the discovery of new knowledge, in an efficient and practical way, but although his researches may eventually have far-reaching consequences in altering the conditions of everyday life, he is cut off from these applications by a long interval of time. It is unusual for any great discovery in pure science to find an application in everyday use in less than thirty or forty years, since this time is required for the technical industrialist to see its possibilities and explore methods of using it for practical purposes. In the War, the pure scientist has to join the applied scientists and become a technician. He has to use his skill and knowledge to aid in devising gear which can be put to practical use in one or two years. A wider world has been opened up to men of science as the result of their being drawn into the War. They see more of the way the country is run. They are accused, with considerable justice, of being somewhat free in their criticism of many of the things they are seeing for the first time. Some of these criticisms are ill-founded, being due to a slowness in realizing that a country is a more complex entity to organize than a laboratory, but some are worth listening to, because they come from a body of men whose discoveries have been largely responsible for introducing the new technological era, which has completely altered the way we all live.

One thing has been clear. It has been of immense advantage to Great Britain in this struggle to have a reservoir of scientific researchers on which to draw. Their contributions cannot be described now, but when it is possible to do so, it will be found that our men of science have played no small part at more than one critical time. We are all hoping that we shall not drift back after the War, but will use our national assets of character and brains to make the country a better one than it has been during the last twenty years. I wish here to take stock of one particular part of these assets, our body of physicists, attempting to see what material we have got and make some suggestions as to how we could train and use it better.

My own experience has been gained in university work, and it is inevitable that this article should reflect the views thus engendered. I should be very sorry, however, if any part of it were taken to indicate a belief that the physicist who devotes himself to pure science has higher ideals or is more representative of his profession than his colleague who devotes his gifts to applied science. It is to our discredit as university men that we should sometimes be accused as a body of holding such views; it is evidence of a failure to take responsibility and enter into the life of the country. I hope, on the other hand, that it will be clear from what I have written that I am seeking to set our own house in order, to see how we can best equip the students committed to our care to take their part in applying their science for the benefit of all.

A Census of Physicists

It is interesting to assess the number of scientists, and of physicists in particular, in Great Britain. An estimate can be got in two different ways which roughly check each other. In the first place, we can find from the records of universities the rate at which scientists are being produced. The calculation is most straightforward in the case of the large modern universities. Each of these, such as Birmingham, Manchester, Leeds, or Liverpool, is the centre of a drainage area separated by watersheds. The students on the whole join that university to which they can travel backwards and forwards daily from their homes, and so one can calculate with some exactitude how many millions of the population each serves. From my experience at Manchester and as external examiner in other universities, I arrived at a rough estimate that one good physicist was bred per year per million inhabitants. By a good physicist I mean a man capable of independent thought, with a flair for his subject. For example, at Manchester, where we had excellent secondary schools seeking out and training all likely material, three or four such men a year was the average product drawn from a population of about four millions.

Again, we now have for the first time a census of the men of science in Great Britain; it is provided by the Central Register initiated by the Royal Society. The card index of the Central Register contains the names of all scientists in Great Britain, together with information about their scientific careers, experience and special interests. The term 'scientist' is not easy to define, but it has been taken to cover all who have received higher scientific education, have taken up a post in industry, Government service or the universities, and have continued to use their scientific knowledge for research or administration. The total number of scientists on the list at the beginning of the War was 12,000, of whom 1,200 were physicists. We may compare this with the above estimate that the population of Great Britain of 45 millions is producing one physicist per million per year; if one takes an average working life of thirty years, the two estimates agree. It is of course true that the relative numbers of scientists in different categories might be changed by a change in the importance and interest of the various branches, but it is doubtful if the grand total could be much increased. The net cast by the system of scholarships is so effective that most school students who show intellectual promise have the opportunity of higher education. One curious exception is to be noted, the very small proportion of scientists coming from the great public schools. Whether this is due to the direction of the brightest boys at these schools into other subjects, or to the fact that boys from the well-to-do homes which can afford a public school education are naturally drawn into other walks of life, I do not venture to judge; but it is an interesting fact, for example, that among the heads of physical laboratories in Great Britain, only one in a hundred received his education as a boarder at a public school. The secondary schools and grammar schools are the source from which the body of British scientists is almost entirely drawn.

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* From a lecture at the Royal Institution, delivered on March 26.

Fundamental Research

How can we best use the physicists which Great Britain breeds, both for pure research and for the equally vitally important industrial research? To take in the first place the well-head from which the flow of scientific thought starts, the fundamental research divorced from all thought of its ultimate use or effect, we may claim that this is one of our great assets. Complacency is always disastrous, and I do not want to be understood as asserting that there are no improvements to be made in the system of combining such fundamental research with university teaching which has grown up in Great Britain. But with all its blemishes, this system has succeeded in keeping our science, and physics in particular, well in the forefront of the world's scientific endeavour, and this success is due to the existing structure.

I think this is worth stressing because ardent reform is in the air, particularly in the direction of a more conscious planning of the fields of research and their division between different centres, and of the foundation of institutions for pure research divorced from teaching. Proposals for the latter should, I think, be scrutinized very carefully. The great asset of university research is the constant flow of young men through the university, bringing their own original and fresh minds to bear on the lines of work of the school to which they come, and of the contacts between men engaged in widely different subjects. Some few men of science remain individualists all through their careers, working alone or with one or two assistants. Examples of physicists of this type must be in all our minds, and we recognize the great contributions they have made to our science. But the majority, after the first decade of their research careers, continue to live their scientific lives for the most part through their students. Battening upon students, using their freshness for selfish ends, is of course one of the major scientific crimes, and unhappy is the laboratory which has such a head, but there is a better and more normal side to the picture. The purest pleasure in scientific work is to see the germ of an idea one has planted in a younger man's mind develop in a way and to an extent one could not have achieved or foreseen oneself, and to see him get recognition for his work. I think too that teaching, if treated as the art of putting ideas in a simple and fascinating way, is one of the great safeguards against getting stale. There are many periods when research goes badly and is disappointing, and it is refreshing to have as a background the regular teaching routine, with the satisfaction it brings of a necessary and congenial task duly accomplished.

In contrast to the flow of keen young research students through a university, a central research institution has a comparatively static staff and there is considerable danger of fossilization. As would be expected, this tendency is much more noticeable in the later stages; it is scarcely likely to appear within the first decade of an institution's existence. It is less likely to occur when the central institution has a constant flow of men through it, who are given research grants and are attracted by the special facilities for work in their chosen line, for such a place is in effect a school for postgraduate study and has the same advantages as a university. Fossilization is seen at its worst in the laboratories where there is no such flow, where members of the research staff enter as young men and continue to do work of much the same character throughout their lives, and where advancement is rather by seniority than merit.

To sum up, it is doubtful, to say the least of it, whether the advancement of pure science is fostered by taking men from universities and setting them to work in central research institutions devoted to some special branch, however fine its buildings and equipment. The necessary stimulus appears somehow to be lost. A curious fatality attends such conscious planning of research. Large endowments given to special fields are apt to produce comparatively meagre results, which are completely outdistanced by some unplanned fundamental discovery appearing at first to have little bearing on the subject. Polanyi (Manchester School of Economic and Social Studies, Oct., 1938) has put this point very well in an article on the "Rights and Duties of Science". It will be objected that a central research institution can provide equipment and other facilities on a scale which may be impossible at a university, and I think that this valid objection points the way to the right solution. The strikingly successful places of this kind are those which may be regarded not as a body of men, but as a body of equipment. Such a place has a nucleus of permanent staff and accumulates traditions of technique peculiarly its own, but its main service is as a place open to all for short periods of intense work, and its main population a changing one.

Physics in Industry

Although we have good reason to be proud of the contributions made by Great Britain to fundamental scientific knowledge, we cannot feel satisfied that full advantage is taken of this asset in our industries. The educational system has a heavy responsibility to bear. In Bernard Shaw's "Major Barbara" the millionaire Undershaft is looking for a successor to whom he can hand over the control of his great armament firm, and deplores the difficulty of finding a boy of native genius who has not been spoilt: "if he shows the least ability, he is fastened on by schoolmasters; trained to win scholarships like a racehorse; crammed with second-hand ideas; dulled and disciplined in docility and what they call good taste; and lamed for life so that he is fit for nothing but teaching."

The bitter truth of this reproach must have struck many who have trained successive generations of honours students at a university. In former days many boys of the right type went straight into industry, and Great Britain's leading position was largely due to their inventive genius. Nowadays the majority get scholarships which enable them to go on to universities, and it is our responsibility to see that we give them the right training and send them back to industry to play their part. Two difficulties stand in the way. In the first place, the boy has lost something vital through the too close attention to his studies demanded by the need to win scholarships and pay his way. We cannot sell him to the industrialist when we have finished with him; he has not learnt to mix with other people and form one of a team, to take responsibility, to trust his own judgment and have initiative. Such qualities are learnt through games, hobbies, camps, running school activities and a host of other things which most boys get but from which the really clever boy is too often largely debarred by being recognized as a potential scholarship winner. In the second place, too many of our best students want safe jobs with immediate returns. The sacrifices they and their parents have made, and the work they have put into their learning, make them feel that their high honours degree should by itself be a qualification for a good post. They regard their training as a guarantee that they shall be put in a senior position, not as a preparation which should help them to show that they deserve one. When they go into industry and come in contact with men who have not had a university training, there is irritation on both sides. The industrialist compares them unfavourably with boys who have worked their way up and become men of the world; the university product cannot understand why the knowledge he has so painfully acquired does not entitle him to immediate recognition.

I have purposely painted the picture in the darkest colours, knowing well how many cases of success might be quoted in refutation, because I wish to consider the remedies. I think the long course through grammar or secondary school and university represents too unbroken a concentration on the acquisition of knowledge. I have on three occasions had the interesting experience of being a visiting professor for several months at various American universities. Although science students in Great Britain may be more advanced on the purely academic side than American youths of corresponding age (they can answer harder examination questions), it was my impression that the American student is more practical, handy, and bold at setting up apparatus. He gets this largely through his experience in the long summer vacation, it being a general practice to engage in some form of manual work. It is not so easy to organize similar activities for our students, though a certain number already are taken on for short periods by industrial firms. I think, even when this is done, that the periods are too short and come too late. The important time to make the break, it seems to me, is between school and university. If all our honours physics students had at least six months working for an apprentice's wage in some industrial concern, before they came to the university, I believe it would be of the greatest benefit not only to those who plan an industrial career later, but also to those who will become teachers of the next generation in due course and should have seen something of a wider world.

One suggested scheme for the future is therefore to copy our engineering confrères, and encourage physics students to put in a spell at works between school and university. Another suggestion is to follow the example of the medical schools. Though a large part of the teaching in a medical school is done by the permanent staff, an important part is that given by practising physicians and surgeons in the form of short specialized courses. Why not invite some of our leading technologists to do the same in our physics schools? As well as giving the students a valuable experience, it would give the industrial experts a place in our universities, a right to take part in their counsels and help to guide their policy.

Finally, there is the possibility of bringing back senior men in industry for short or long university courses specially arranged for them. Such courses can range from a conference devoted to intensive study of some special branch lasting for a few days or a week to a refresher scientific course extending over months. There is one conclusion to which I have come, as a result of being concerned in the organization of short courses of this kind, which applies to all types. The most successful examples are those where the university has concentrated on giving the industrialists a well-prepared summary of recent advances in pure or fundamental science, not those where it has attempted to go outside its own field and talk about "Physics in Industry". Let each man stick to his own job. Advances are so rapid, the literature is so voluminous, that a busy industrialist must find it difficult to keep abreast of the times. This is where his university colleagues ought to be able to help him, if they are worth their salt. They can sort the wheat from the chaff, tell him what new ideas are important and what are not, and provide him with a background of knowledge which he can use to solve the many problems of his particular industry. The industrial physicist on his side has something to which the university physicist cannot aspire, a wide and expert knowledge of the many problems of his industry and a sense of values as to what is important to it. It is for him to see how this new knowledge may aid him.

The same consideration applies in another way to research carried out in the universities at the behest of industry, and perhaps supported by it. Such arrangements forge the links closer, which we all desire, and can have highly important results. They must fit in, however, with the main function of university research, which is to increase the body of fundamental knowledge irrespective of its immediate application. This separation of function must be kept in mind. Any knowledge discovered at a university should be free to all, and the university scientist should not be forced to keep his knowledge in water-tight compartments, to remember what he may divulge and what he must regard as the peculiar property of a particular outside body which is financing a research in his laboratory. Freedom of discussion and exposure of his work to general criticism are the breath of life to the university worker.

Physicists in the Service of the State

The industrial research associations and laboratories partially or wholly supported by the nation, which have been started since the War of 1914–18, are in some respects in an intermediate position between the universities and industry. Their work is designed to help their particular industry, but they are also repositories of general knowledge and are in a position to undertake long-range research which will ultimately benefit the whole industry, as well as to apply themselves to particular problems of immediate interest.

With no disparagement of the achievements of these associations, and with full recognition that they represent a new experiment in organization of scientific endeavour, in planning for the future one cannot consider that the last word in defining their scope and function has been said. They have peculiar difficulties of their own. The university research worker is kept on the alert by the excitement of the chase. He is free to pursue any fascinating line which opens up, irrespective of its applications. He is hardened by the unsparing criticism of other experts if he makes mistakes of fact or logic, since his work is published and runs the gauntlet of free discussion. The industrial physicist is kept on the alert by the demands of his industry. What he is doing may affect the success or failure of a costly process, or lead to a new product for which a wide demand is anticipated. He runs the gauntlet of criticism by his colleagues in the works, and of the fierce test of results. The danger of the research association is that of its men working in a vacuum, where they miss both of these incentives.

I am emphasizing the difficulties of the research associations, not minimizing their achievements or suggesting that the experiment ought to be discontinued, a proposition to which I should be the fiercest of opponents. One ought, however, to face the existence of a widespread opinion that the flow from the research associations of Great Britain of fundamental ideas which would profoundly affect our industries has not yet reached the volume which had been hoped for and anticipated. Lip service is paid to research because it is respectable and fashionable to do so, but responsible industrialists in private express their disappointment. This is a challenge which must be met.

It seems to me that the difficulty partly arises from a wrong conception of the nature of research. To set aside a definite body of men, in a central institution, with orders to spend their whole time on research with some definite end in view, is to court disappointment. I come back to the idea of a central research association as being ideally a permanent laboratory with specialized equipment but with a changing population, not as being a permanent body of men.

While at Manchester I had an arrangement with certain firms which worked successfully. If one of their staff had a good idea, and the firm wished him to develop it without being subjected to the distractions of the works and its contacts, he was given a quiet laboratory at the University as temporary quarters. Should not the industrial research association be a place to which firms send suitable men from time to time, where equipment and assistants are available, and where they can for a year or more develop some good idea of the longer-range type? This plan has already been followed; I claim no originality for any of the ideas put forward here, but merely record those which I believe to be along the right lines. The opposite side of the picture is one which is only too commonly seen. A committee sits to direct a certain branch of research and a member proposes an investigation as worthy of attention. Staff and apparatus are set aside for it at the research association, and the men do their best to devise a technique and frame a programme. Through imperfect contact with industry, they drift off on work which may be excellent, but which is not really along lines of profound value. A committee is too impersonal a body to direct research, its members are generally too busy and important to give the necessary time and attention to detail.

When a new line of this kind is started in response to a demand by industry, it would be generally advantageous if at the same time an industrial sponsor were appointed, not necessarily a member of the committee, whose special responsibility it would be to visit the laboratory at short intervals and to spend quite a large part of his time in directing the effort. This is what in fact has happened in this War, and it is highly successful. Many extramural researches for the Services are being carried out in laboratories all over the country, and bodies like the Ministry of Supply appoint men from industry or from their own staff with precisely this function, who visit the research workers, who can be consulted freely, and who give just the required contact with what is actually needed. A day every other week of one expert's time is of infinitely more value than an hour or two of a large committee of well-known men which meets every two or three months. A similar plan widely carried out for industrial research would meet the need I have tried to express above; for the time being the sponsor drawn from industry would use the research association as his laboratory, to carry out his ideas, and there would be a constant flow of new people with new ideas through it.

Research and Administration

Some change in the methods by which Government scientific research is administered and financed appears to be very desirable. The Civil servant is, of course, right when he insists that everything should be done 'through the proper channels', and that attempts to short-circuit them lead to increased confusion and are essentially ineffective. There must be a recognized chain of authority by means of which action is taken. What we should ensure is that these channels are direct and open, not tortuous and clogged. It is here that sometimes one feels tempted to criticize the administration of research which is paid for by the Government, particularly research for the Fighting Services. An apparatus which is well designed for the administration and financial control of other classes of activity is inappropriate when it is applied to scientific research and development.

I believe the universities treat this problem in a better way. The ideal research unit is one of six to twelve scientific men and a few assistants, together with one or more first-class mechanics and a workshop in which the general run of apparatus can be constructed. I will add one further requisite: not only a good store of material but also of 'junk', old gear which has passed out of service but which provides a priceless source of oddments which can be used in constructing rapidly a first rough apparatus to try out some new idea. A famous man of science of a very practical turn of mind once told me that he regarded this junk as one of the most valuable assets of his laboratory; he was at the time feeling the pinch of moving into a tidy new building in which it had not yet had time to accumulate. Few who have an inspiration for a new piece of apparatus can visualize exactly how it will work to the extent of making a blue print of it. It grows by the close personal contact between researcher and mechanic, who should work side by side. It is not wasteful to duplicate lathes and other machines by giving each group its own workshop; the time of researchers is far more expensive than the overheads on machinery. With the same object in view, that of allowing the researcher to try out his ideas with as little delay as possible, the decision as to what particular piece of apparatus should be bought is best left to the researcher in all but major items. He should have an allowance for apparatus, to be spent at his discretion. The bills are passed through a central office, but the important thing is that the researcher should be free to get what he wants while in red-hot pursuit of the idea, and not have to wait to convince a central authority that it is necessary and order through it. This makes for true economy in the long run.

It may be objected that the freedom from control advocated here would be abused if it were granted. The point to be made in answer is, I think, that the check upon expenditure should be one of general review at the end of regular periods, not one of each detail.

Appointments

The working of the Central Register has been so interesting that one would like to see a permanent body with the same function set up after the War. We train our students for three or more years at the university, devoting much time and energy to their preparation for their careers. Do we pay an adequate amount of attention to directing them into the right careers when they leave us, a matter which is in every way as important as their training ?

Students are helped to find posts in two ways, either through the head of the department in which they have worked, or through a university appointments board. Outside bodies often apply to appropriate heads of departments when they have a post to fill, and consider they may have students of the right type, and much effective placing of square pegs in square holes is done in this way. However, I have always felt, as head of a department, that too much is left to chance by relying on applications of this kind.

A university appointments board has a better opportunity to survey the whole field both of posts and men, and many such boards do excellent work. They have their own particular difficulties, however. Too often the best men are placed by heads of departments or by their own efforts, without consultation with the appointments board, and the latter is saddled with the difficult task of finding posts for the less attractive candidates. This reacts unfairly on its reputation for supplying good men, and it also means that its wider knowledge of the field is of little use just where it should be most important, in the matching of the very best men with the best posts. An appointments board of the right kind should be the channel through which most appointments are normally arranged, not a last resort of the desperate.

I cannot help feeling that it would pay us handsomely to centralize the arranging of appointments of physicists after the War, much as it has been done during the War. Any central board which did this work for the whole of Great Britain would require an absolutely first-rate man at its head whom we could all trust, for he would have grave responsibilities, but the task is so important that it is a worthwhile one for such a man. I envisage the board as keeping a dossier of every physicist in the country, such as the Central Register now has in its records. The total crop of young physicists each year is two to three hundred, a comparatively small number to handle, and the total number in Great Britain is, say, ten times as great (any more precise estimate depends on the definition of a physicist). It should not be difficult to establish a central channel for advising men about suitable posts and helping the very best men to get the most important posts, as each year's contingent comes to be considered. I know that I, as head of a physics department, would feel much more confident that my students were taking up the right work if I had such a centre to consult. I would feel that it had a much wider knowledge of the possible careers than I could attain to by my own rather sporadic efforts, because all employing bodies would consult it when once its reputation was firmly established.

The implication of this suggestion will be realized. It is in effect a proposal to organize appointments boards by subjects rather than by universities, and would require careful planning before it could be made effective. The intimate personal knowledge of the student acquired by the department in which he has worked is fundamental to any scheme, but the War has taught us the value of having one centre for the whole country.

Summary

The foregoing appraisal of our assets and our problems may be summarized as follows. We breed the right kind of physicist, and the combination of pure research with teaching at our universities, together with the constant flow of young research students through university laboratories, is effective in producing fundamental advances in pure science of the highest quality. We are not so successful in using this asset in the field of applied physics, and some of the causes are analysed here and remedies suggested. The training of our physicists is literally too academic. This does not perhaps matter so much in the case of men taking up pure research, but it is a big handicap to the men going into industry. It is suggested that more of our physicists, now that their subject has made a recognized place for itself in industry, should have works experience as engineers do, and that the best time for the relatively shorter period they can afford to spend in works is between their school and university. An early experience of this kind would make it easier for the student to take his place in industry when he leaves the university.

We wish to ensure that the undoubted inventive genius and scientific ability of the students we train is used by industry to the best advantage. Striking successes have been achieved by industrial organizations which are large enough to have research laboratories of their own. The close contact with the works provides the inspiration and sense of practical values which are essential for fundamental and original ideas profoundly affecting the industry. Research associations represent an attempt to advance the standard of technical achievement for groups of firms, many of which cannot afford laboratories of their own. Although such associations have scored many successes, they have been successes of tactics rather than of strategy ; the conditions under which they work make it difficult for them to produce the really fundamental ideas. It has often been stressed that a primary requisite for their success is that the firms which support them should be willing to pool their knowledge and consent to problems which they know to be really important being handed over to a central organization ; no scheme can hope to work unless this is done. If such a pooling is carried out by general agreement, it would be possible to alter the character of a central research organization. At present its greatest danger is that of becoming a static body of researchers cut off from the real needs of industry. It should be able to become a common research centre with a continuous flow of men through it, providing a laboratory where any man with a good idea could come to work it out, and a source of men going back into industry with a wider knowledge of all its problems. It is only under such conditions that really fundamental advances can be made.

THE EYE IN INDUSTRY

CURRENT interest in the health of industrial workers and in the maintenance of a high level of output made the conference on the "Eye in Industry", held under the auspices of the London Branch of the Institute of Physics on June 20, very opportune. During the first half of the proceedings six papers were given on different aspects of the subject, followed, after tea, by a lively discussion, in which many of the audience took part. The success of the meeting was enhanced by the kindly hospitality enjoyed at the South-West Essex Technical College, where the conference was held.

In the opening paper, Dr. W. D. Wright gave three reasons for a discussion on the eye in industry as opposed to the eye in other spheres of human activity. There is in the first place the special nature of many of the tasks that have to be undertaken and that are peculiar to industry, tasks, moreover, that have to be repeated and continued for many hours at a stretch. Secondly, there is the question of responsibility, either on the part of the employer or possibly of some Government department, for the health of the workers. In the home, the individual should, so far as his means permit, make his own arrangements for good lighting and avoidance of eyestrain, but in the factory the onus rests on the employer. Any discussion should therefore aim at stirring the interest and the conscience of the employer, providing him with the data that he may properly demand and informing him of the facilities already available for the adequate solution of visual problems. There is thirdly the question of output and efficiency, matters closely related to good seeing.

Hence, although the eye responds in the factory in much the same way as it responds elsewhere, yet there are excellent reasons for paying special attention to its performance under industrial conditions. The importance of the eye, as distinct from the other sense organs, lies, of course, in the fact that a very large fraction of our knowledge of the external world is derived visually. Nearly all the information which we have of our immediate surroundings and of the events taking place in the vicinity is obtained from the very variegated pattern of light, shade and colour which is focused by the lens system of the eye on to the light-sensitive retina. Shape, size, texture, distance and movement of an object are all observed and recorded because of the existence of contrasts between the object and its background and between different markings on its surface, as in the grain in a piece of wood, so that good seeing demands good contrast perception. Attention has to be paid to the image-forming part of the visual system, as this may be defective and require correction with spectacles, and also to the performance of the light-sensitive mosaic on the retina, which can detect small contrasts and resolve finer detail when the level of illumination is raised. Eyestrain occurs when the muscles controlling the convergence of the two eyes on to the object under examination and those governing the focusing of the lens system have to operate under conditions of poor visibility and distracting lighting. It is the job of the employer to provide conditions that achieve the best possible compromise between the requirements of his technical processes and the maintenance of maximum visual efficiency.

Mr. E. W. H. Selwyn illustrated this compromise by reference to the peculiar problems that arise in the photographic industry in connexion with the illumination of dark rooms. Sufficient light has to be provided to conduct the various photographic processes, but not so much as to fog the emulsion. In choosing the colour of the light to be used, a balance has to be struck between the parts of the spectrum to which the photographic emulsion is least sensitive and the eye most sensitive, taking into account the changing spectral sensitivity of the retina in dim illumination. It follows that the most efficient colour of the illumination will vary with the type of emulsion: orange for ordinary emulsions, red for the orthochromatic type, and green for the panchromatic and infra-red forms. In all cases the level of illumination is low, leading to poor visual acuity and contrast perception. As a consequence, objects such as dark room clocks must be large, and white markings should be provided to assist in getting about the dark room—aids reminiscent of the black-out.

Another interesting aspect of the problem is concerned with the time required to become adapted to the dark room illumination. In rooms illuminated by red light, vision, even when fully adapted, is mediated largely through the cone mechanism in the retina and the cones acquire their maximum sensitivity after only a few minutes. In the rooms illuminated by green light, on the other hand, the rods will operate, and as these take at least thirty minutes to acquire their maximum sensitivity, there is a marked difference in the adaptation times for the two forms of lighting. Mr. Selwyn also reported his experience that when working in a dark room he found that he required the aid of negative lenses with a power of -2 dioptres in order to focus distant objects clearly. This he attributed to the spherical aberration in the lens system of the eye, since at low intensities the iris is expanded and the marginal zones of the system come into action. There was some difference of opinion on this matter during the discussion, both as to magnitude of the effect and its cause. It would appear that some observers have not been conscious of the need for negative lenses; indeed, one speaker maintained that positive lenses were required, yet it is not a matter that should be lightly dismissed without further investigation.

The part played by light in aiding the performance of the eye was dealt with by Mr. W. R. Stevens. He stated the basic principles of good lighting, including adequate illumination, reasonable uniformity, freedom from glare and the provision of the proper contrast between the object and its surround. He urged the greater use of colour, both as a means of improving contrasts and in brightening our workshops; in Great Britain we tend to be conservative in our devotion to greys and other dull colours for the decoration of machinery, with the notable exception of the gaily coloured agricultural machines. An important advance in the last few years has been the introduction of the fluorescent tube as a light source; its extended area and low brightness result in a reduction of hard shadows and the absence of glare, while through the choice of the fluorescent material, the colour can be controlled very successfully. A good approximation to daylight can be obtained, and, through the employment of daylight fluorescent lamps, the illuminating engineer can mix artificial light with daylight without introducing the disturbing æsthetic appearance noticeable when ordinary tungsten lamps are used in a room which is simultaneously being illuminated by daylight.

Questions were asked about the extent to which the design of lighting installations should attempt to simulate daylight, both in its colour and distribution; the evidence goes to show that generally we prefer the lighting to which we have been accustomed, so that any tendency towards one particular form of installation has no justification from experience. The design of windows and daylighting is largely an architectural problem, and for illuminating engineers to arrange their lighting fixtures to give an imitation of window lighting would impose an unnecessary, artificial restriction on the freedom they otherwise possess.

Mr. G. H. Giles, who spoke from the point of view of the optician, claimed that the optician is in a position to act as a clearing station for the specialist—the physicist, the illuminating engineer, the medical practitioner. There is a very obvious need for close attention to refractive errors among the workers in industry, since statistics, many from the United States, show that the percentage of workers with visual defects is very high. Correction of the defects with spectacles leads to roughly 20 or 30 per cent increased production, with a corresponding decrease in the discomfort and fatigue of the worker. Naturally, there is a greater tolerance for defects in one type of work than in another, but there are occupations where visual aids are desirable, even though the vision of the worker is normal. Thus, where prolonged close work is involved, it has been found that much of the strain can be removed if the worker wears a pair of glasses which combine a lens and prism for each eye. In this way most of the need for excessive focusing and excessive convergence of the two eyes can be avoided, with a consequent lessening of the muscular effort; Weston and Adams have shown that great benefits have resulted from the use of such aids, leading to a marked reduction in fatigue and eyestrain, and a significant increase in output. During the discussion, the value of spectacles of this type was especially emphasized in the case of prolonged near work and it was considered that they could be employed on a far wider scale than is the case at present.

Tests for eye defects other than refractive errors, such as colour blindness and defective night vision, may also be needed. Recently, a number of workers at a factory claimed to have poor night vision, but when tests proved them to be normal, it transpired that they had hoped in this way to avoid fire-watching duties! Opticians also deal with protective glasses against damage from different radiations and from other hazards such as flying chips and molten substances. Finally, Mr. Giles referred to a scheme inaugurated by the Joint Council of Qualified Opticians for testing the vision of factory workers, whereby a rota of opticians is made available for the purpose. A valuable service was being performed in this way before the War, but during the War the scheme has proved even more useful and has been officially adopted for Royal Ordnance Factories.

The routine eye examination carried out by opticians under the scheme of the Joint Council of Qualified Opticians was described in some detail by Mr. R. A. Rider. As the testing of each patient may occupy at least thirty minutes, the time required to deal with a works in which, say, 20,000 persons are employed is very great. The tests may therefore have to be directed in the first place to those who show symptoms of ocular defect.

In the final paper Dr. H. Lowery broached a rather different aspect of the subject when he referred to the part played by the eye during training for such activities as carpentry, metal work and other technical handicrafts. This is very much a question of securing proper co-ordination between hand and eye and it is important, especially at the present time, to know why and how training improves the visual processes. Before the War of 1914–18 it was customary in schools to give special classes for what was called "eye training", but since then the method has been discarded. It is undoubtedly in part a psychological problem, as are, in fact, all visual problems, and training undoubtedly induces alertness in making particular types of observation. In the discussion, for example, reference was made to the very high accuracy to which a trained workman could judge angles and other dimensions of an object. Another point was made that, in problems of discrimination and visual estimation, the boundary line between physiology and psychology is rather vague, so that the possibility that training may modify the response of the eye as well as the reaction in the brain ought not to be overlooked.

There is obviously a great deal still to be learnt about how the eye works and how to apply the information that is available. The problem is a vast and intricate one and the conference served to bring different interests together to form a pool of knowledge, knowledge that has somehow to be passed on to the whole industrial community.

CANCER RESEARCH IN GREAT BRITAIN

THE eighteenth annual report of the Grand Council of the British Empire Cancer Campaign (11 Grosvenor Crescent, London) was issued in February. At the meeting at which the report was presented, it was stated that more cancer research had been carried on during the War than had been anticipated in 1939. The summary refers with justifiable pride to "the lead in cancer research which Britain is still giving to the whole world". On account of this, appeals for financial assistance for the Campaign which had been discontinued at the beginning of the War will be made again.

The report itself has its familiar form, and shows that a considerable amount of work has been carried out in Great Britain, though there is little research to report from the Dominions. During the year which ended last summer the campaign expended almost £45,000 in supporting research workers and institutions.

Advances in our knowledge of cancer have been made in many countries. Important contributions have been made in the United States to our understanding of the nature of filterable tumours and the inheritance of cancer in mice. Japanese workers have made important discoveries on the experimental induction of liver tumours. But "the study of cancer-producing and cancer-inhibiting substances is predominantly a British study". Perhaps the most interesting carcinogenic agents are those which occur in living organs. The first descriptions of such substances came from Russian workers. Examination of bile and liver tissues has been carried on in Great Britain, and tumours have been produced in mice by injection of extracts of human livers.

The testing of more than seventy compounds related to known carcinogenic compounds during the last three years at the Royal Cancer Hospital has shown that the capacity to produce skin tumours by painting does not always run parallel with the capacity to produce sarcomata by subcutaneous injection.

Progress has been made in the study of the metabolism and excretion of carcinogenic hydrocarbons. The fluorescence of these compounds makes it easy to follow their excretion. At the Royal Cancer Hospital it was shown that when 1 : 2 : 5 : 6 dibenzanthracene is fed to rabbits it is excreted in the urine as a dihydroxy derivative, and later American work has confirmed and extended this finding. Prof. F. Weigert and Dr. J. C. Mottram have shown that the fluorescence of benzpyrene varies from blue to violet in animals injected or painted with the compound. The blue fluorescence is seen in the bile of treated animals. At the Glasgow Royal Cancer Hospital, work on the metabolism of benzpyrene indicates that a hydroxy benzpyrene is excreted in the bile of animals injected with the hydrocarbon.

Workers at Leeds have produced tumours of the bladder in dogs after very prolonged dosage of pure β-naphthylamine by mouth. This confirms the earlier work of Hueper in the United States, and indicates that β-naphthylamine itself is probably the primary cause of cancer of the bladder in dye workers. Careful research carried out in Newcastle-on-Tyne has shown that wood smoke such as is used for smoking food is not carcinogenic to animals.

Most carcinogenic compounds inhibit the growth of normal and malignant tissues, and the correlation between carcinogenicity and growth-inhibiting power has been thoroughly investigated at the Royal Cancer Hospital. Two compounds—1 : 2′ azonaphthalene and 1 : 2′ diamino 2 : 1′ dinaphthyl—have been found to be inhibitory but noncarcinogenic. It is suggested that some compounds of this type might be tested clinically for treatment of cancer.

Animal tumours can be grown in tissue culture and often, on retransplanting into animals, lead to development of tumours. A mouse tumour grown *in vitro* in this way in Birmingham for more than eight months was able to produce tumours in mice and then lost this power of growing *in vivo*. In Glasgow a fowl tumour grown in tissue culture did not always produce tumours when inoculated into fowls. There is evidence that tumours while still growing in tissue culture may lose their ability to grow in animals.

Photomicrography of irradiated malignant tissues, using monochromatic ultra-violet light, shows the position and amount of nucleic acid material in cells. In eleven out of fifteen cases examined, a striking increase in nucleic acid in the cells occurred after irradiation. The increase in nucleotide material is not confined to malignant cells, but has also been observed in normal and hyperplastic tissues.

In spite of difficulties due to the War, progress in technique of therapy by radiological methods continues. At the Mount Vernon Hospital it has been shown that treatment of carcinoma of the vulva with a given dose (1,200 r.) is much more effective if given at high intensity (350 r. per minute) than if given at low intensity (20 r. per minute).

At St. Bartholomew's Hospital more experience has been gained in the clinical application of the million volt X-ray apparatus. An increasing number of patients is being treated and the results obtained suggest that it is particularly effective in treatment of cancer of the rectum, a site in which treatment by softer X-rays has not hitherto yielded satisfactory results.

Mr. E. N. Willmer in Cambridge has examined the effect of trypsin on cultures of chick heart fibroblasts. A 1 per cent solution of the enzyme had only slight toxic effects but caused the cells to round off. A more dilute (0·1 per cent) solution caused the constituent cells of embryo chick heart tissue to fall apart. The separated cells were able to grow and form new colonies of cells.

Dr. A. W. Greenwood has continued to supply chicks and fowls to research workers investigating the pathology of fowl tumours. Careful observation and breeding of Brown Leghorn chickens has shown that there is considerable variation in susceptibility of this stock to the Rous No. 1 sarcoma. The inheritance of variation in susceptibility is being studied. The susceptibility in any one bird is not necessarily extended to all tumours. Thus a transplantable chemically induced tumour grows in birds from a strain resistant to the Rous No. 1 tumour agent.

Variation in reaction to the Rous tumour virus has also been encountered at the Middlesex Hospital, where the birds of a Light Sussex - Plymouth Rock cross could not be immunized, while Brown Leghorn fowls readily develop immunity to concentrates of Rous sarcoma. The low resistance of the Light Sussex cross-bred fowls may be connected with the capacity to yield chemically induced filterable tumours which have occurred in these fowls at the Middlesex Hospital laboratories. The serum of susceptible fowls may be able to agglutinate the Rous virus without neutralizing it, while the serum of resistant fowls may contain neutralizing antibodies without agglutinins.

Many efforts have been made to demonstrate a virus in 'non-filterable' tumours. At the Glasgow Royal Cancer Hospital filterable and non-filterable tumours have been compared by inoculation of tumour material which has been ground with and without sand. Filterable tumours are still transmissible after grinding with sand, but the infectivity of other tumours is destroyed by such treatment. Filterable tumours transmitted with ground tissue "grow in a diffuse manner with ill-defined edges, so that the muscle substance is deeply infiltrated over a wide zone". The non-filterable tumours grow from multiple foci, suggesting that they have developed from isolated cells or cell clumps; such tumours depend for their transmission on the inoculation of a sufficient number of viable cells. Work in the field laboratory at Sheffield indicates that the simultaneous injection of mouse tumour tissue treated with glycerol does not influence the incidence of tumours induced in mice by the injection of methyl cholanthrene.

The Clinical Cancer Research Committee of the Campaign presents a report in which material collected in 1938 and 1939, particularly with regard to uterine cancer, is considered in detail.

The body of work which is reported indicates that the impetus of cancer research in Great Britain even in war-time is considerable, and that with a return to peace-time conditions extremely rapid progress should be made.

E. Boyland.

ECONOMIC VALUE OF THE COMMON STINGING NETTLE

By DR. C. R. METCALFE
Royal Botanic Gardens, Kew

It is a well-known fact that the common nettle (*Urtica dioica*) yields a very strong bast fibre which was used in Great Britain until about 1860 for the manufacture of cloth. Since then its use has been discontinued because other cheaper, imported materials became available. In the past, nettles have been cultivated also in France and other parts of Europe for the production of fibre.

During the War of 1914–18, the Germans were quick to recognize the value of the nettle as a source of fibre. According to published information, 10,000 tons of wild nettles were estimated to be available in Germany. The collection of these was undertaken largely by children; transport being arranged in collaboration with the military authorities. The whole organization was controlled by the "Nesselfaserverwertungs-Gesellschaft" and the "Nesselanbau-Gesellschaft" which operated from Berlin, while the "Bayerische Nesselfaser-Gesellschaft" had offices at Munich. The estimated yield was between 1,500 and 2,000 tons of fibre, valued at between two and three million marks. This was to be used chiefly in the manufacture of textiles. At the same time, 3,000 tons of food from the leaves and 3,000 tons of by-product material suitable for use in paper and chemical factories were to be extracted. Other extracts included lignin, chlorophyll and potassium nitrate, while nettle products were even used in the manufacture of gas mantles[1].

At the outbreak of the present War, the German Government immediately appealed to the general public to collect nettles once again[2]. Apparently the nettles are still being used with success, for it was reported from Stockholm in the *Daily Express* on June 8, 1942, that about 5,000 railway carriage loads of stinging nettles will be collected in Hungary this summer for use as raw material for textiles.

Although most of these facts have been known in Great Britain for many years, it is only recently that it has been possible to arouse any interest in nettle fibre in commercial circles. The availability of more familiar fibres, and other causes, have closed our eyes to the possibility of making use of a very common and troublesome weed. About two years ago, however, samples of nettle bast fibre were extracted at the Royal Botanic Gardens, Kew, and sent to another institution for certain experiments which were then in progress. Tests, which were then made, fully confirmed that the bast fibre is remarkably strong and that it consists of a very pure form of cellulose. Other tests on fibre extracted at Kew were also made at the Imperial Institute, where it was demonstrated that good-quality paper can be made from the bast fibre. Larger samples of nettle fibre were prepared in 1941, which were examined by paper-making firms in Scotland, and pronounced to be very satisfactory. From the *World's Paper Trade Review* of May 15, 1942, it is learned that a Renfrewshire firm of paper-makers is prepared to purchase 1,000 tons of nettles this summer at a minimum price of £10 per ton, and that another firm in Fife is willing to buy 200 tons for experimental purposes. In the same journal it is also stated that steps have been taken to cultivate several acres of nettles for the same purpose, care being taken to do this only on land which is unsuitable for other crops.

It must be emphasized that the samples extracted at Kew consisted only of the bast fibre; the wood fibre, which possesses quite different properties, was a waste product. Unfortunately, it is difficult to reduce the wood fibre to pulp, so that this material cannot be used unless new and less expensive methods of treating it can be devised. The bast fibre represents only about 8–10 per cent of the dry weight of the nettle stem, so it can be seen at once that a considerable amount of material is likely to be wasted unless methods of preparation can be improved, or an alternative use found for the by-products. It is also important to emphasize that the quantity of available nettles is never likely to be sufficient to satisfy more than a small fraction of the paper requirements of Great Britain. The most promising line, therefore, would appear to be to make good-quality paper for special purposes. Whether it would be economically possible in Great Britain to use nettle fibre for textiles as in Germany needs further investigation.

It is not generally known that differences in the standard of living in Great Britain and Central Europe respectively made it economically possible to import dried stinging nettles from the Continent before the War. This material was used for the extraction of chlorophyll, which is employed to give a green colour to soap and other toilet preparations and, to a limited extent, in medicine. Nettles are more favourable than other plants as raw material for this purpose owing to the ease with which the chlorophyll may be extracted, as well as to the desirable shade of green which it exhibits. A great deal of the chlorophyll used in Great Britain before the War was imported ready-made from the Continent. It will be interesting to see whether, after the War, economic conditions will be such as to enable or make it desirable for us to import this material again.

There is, meanwhile, an admirable opportunity to extract chlorophyll for export to those countries which, like ourselves, were previously supplied from the European Continent. The desirability of effective collaboration between those who cultivate nettles for fibre and those who wish to use the leaf for the extraction of chlorophyll is clear for all to see. We might also emulate the German skill in using *Ersatz* material by devoting any excess of leaves to the feeding of cattle, even if the well-known value of young nettles as human food fails to command much popular respect. It is interesting to note in this connexion that the protein content of the nettle is high.

[1] Ulbrich, E., "Fasern" in "Ersatzstoffe aus dem Pflanzenreich", edited by L. Diels, Stuttgart, 1918, 318–87. Pp. 355–63 deal with the fibre of *Urtica dioica*.

[2] Anon., *Jute Abstracts*, 3, 9, 235.

OBITUARIES

Prof. G. A. Reisner

THE death on June 6 last of George Andrew Reisner, professor of Egyptology at Harvard University, has removed from our midst one of the greatest and most successful excavators Egypt has ever known. His rival for the foremost place could indeed only be Sir William Flinders Petrie, his senior by some ten years, who is happily still with us. To assess the comparative merits of these two would be invidious, but a few sentences may perhaps attempt to sum up the special merits of each. Petrie has been essentially the pioneer. Before him, excavation was but a haphazard affair; no attention paid to detail, often in fact left to untrained native foremen. Petrie's field-work, starting full fifteen years before that of his American colleague, was the first to inaugurate careful planning of sites, with complete recording of pottery and smaller objects; and the prompt annual publication of results has been the greatest boon to our science. It cannot be gainsaid that Reisner greatly improved upon Petrie's methods. Never has there been such meticulous regard to the smallest objects, photography applied at every stage, the most careful training and organization of the workpeople, voluminous notes compiled with unremitting patience; and scholarly philological training at the back of it all. Alas, the inevitable consequence of such minuteness has been that publication has often been unduly deferred. Reisner's books are fairly numerous, always bulky, but their content covers only a fraction of the work that he achieved. It is devoutly to be hoped that those into whose hands his material now passes will repair the miscalculation here deplored. Thus only shall we be enabled to measure the full stature of the man, and derive complete profit from the astonishing achievements of his career.

From early work on cuneiform tablets, for which he received his training in Berlin, Reisner soon switched over to Egyptian studies, and in 1899 took charge of the Hearst Egyptian expedition to Upper Egypt. Here he unearthed important cemeteries of the early periods, especially at Naga ed-Dêr, near Girgah. In 1905 began the excavations on behalf of Harvard University which were continued down to his death, interrupted only by the three years spent in charge of the Egyptian Government Survey in Nubia (1907–9). Investigations in various Nubian cemeteries led on to excavations much farther south, when the tombs of many late Ethopian kings were discovered, and a most interesting settlement of Middle Kingdom date explored at Kerma. Two seasons at Samaria (1909–10) brought to light the palaces of Omri and Ahab, with many important remains.

But it was in the neighbourhood of the Pyramids of Gîzah that Reisner scored his greatest successes. The laying bare of the temple of the Third Pyramid resulted in the discovery of marvellous statuary, chief among which was the great slate group now in Boston of King Mycerinus and his mother. Even more valuable were the results of the excavations around the Great Pyramid. Here the symmetrically laid-out necropolis city of the nobles and princes of the time of Cheops was systematically investigated, the crowning find being that of the secret burying-place of that Pharaoh's mother, Queen Hetepheres. The chaste sobriety of the magnificent furniture found in this untouched burial forms a remarkable contrast to the far richer, but sometimes garish, treasures from the Theban tomb of Tutankhamūn, the most sensationa archæological discovery ever made.

This inadequate account cannot conclude without a brief impression of the man himself. He was an American of the Americans. With his powerful figure and forthright utterance he reminded one of Theodore Roosevelt, but hand in hand with these somewhat awe-inspiring characteristics went a kindness and hospitality unforgettable for those who, like the present writer, often benefited by them.

ALAN H. GARDINER.

Mr. C. C. A. Monro

CHARLES CARMICHAEL ARTHUR MONRO, who died on June 21, came of a Scottish family, that has had many distinguished members. It included three generations of professors of anatomy at the University of Edinburgh, all bearing the name of Alexander Monro, the second of whom (1733–1817) has given his name to the "foramina of Monro", which connect certain ventricles of the vertebrate brain. His great-grandson, David Binning Monro (1836–1905), was provost of Oriel College, Oxford, and a well-known Homeric scholar. Charles Monro was born in India on September 14, 1894, the younger son of the late Alexander Monro, who was director of public instruction, Central Provinces, and whose elder son, Alexander Monro, has also had a distinguished career in the Indian Civil Service. An uncle, the late General Sir Charles Monro, was commander-in-chief at the Dardanelles in 1915, and afterwards Governor and commander-in-chief of Gibraltar.

Monro was educated at Charterhouse, Eton (where he was a King's scholar) and Trinity College, Oxford. Going up to Oxford in 1913, he took Pass Moderations in Classics in 1914, and began to read for the Honour School of Lit. Hum. His studies were, however interrupted by the outbreak of war. He served in France and Belgium, and was wounded and suffered shell-shock in 1916. Returning to Oxford in 1920, Monro, who had become interested in zoology, decided to read for the Honour School of Natural Science in that subject, and did so until 1922.

After brief experiments in business and agricultural practice, Monro was appointed in November 1922 to an assistant keepership in the Department of Zoology, British Museum (Natural History), and was placed in charge of the collections of Annelids and Echinoderms. While doing a good deal of curatorial work on these collections, and being responsible for their removal from the Old to the New Spirit Building of the Museum in 1924, he devoted his attention mainly to the Annelids, and in particular to the Polychæte worms. In the course of the years 1924–39 he published some thirty-seven systematic memoirs, many of which were important contributions to the subject. They included, besides smaller papers, extensive reports on the large collections obtained by the *Discovery*, Great Barrier Reef, John Murray and B.A.N.Z. Antarctic Research Expeditions, as well as reports on collections made by smaller expeditions (*St. George*, *Rosaura*, etc.). There can be no doubt that Monro was well on the way to become a leading authority on the Polychæta. An interesting investigation of his was that on a species of Serpulid new to British waters, which he named *Hydroides incrustans*. This was found forming extensive incrustations in an enclosed harbour canal in Sussex where, owing to the discharge of hot sea-water from a power-station, the temperature of the water was many degrees higher than in the adjacent part of the English Channel. Monro felt some uncertainty whether the worms represented a species accidentally introduced on the bottom of a ship from a warmer climate, or whether the high temperature of the water had produced a neotenic race of a widely distributed species, *Hydroides norvegica*, showing well-marked differences in size and structural details from the typical form.

In one of his shorter papers Monro discussed the need for a re-classification of the Echiuroidea, and made some important proposals for the rearrangement and redefinition of the families and genera of that group. He was responsible for the reorganization of the starfish gallery of the Museum in 1928, and also rearranged the study collection of echinoderms in accordance with modern classification. Almost the whole of the "General Guide to the Exhibition Galleries", published by the Museum in 1931, was written by him. He edited, for publication by the Museum, a series of postcards dealing with the old herbal "Hortus Sanitatis", a task in which his considerable knowledge of medieval Latin proved of great value. One of his last official duties at the Museum was the preparation, jointly with the present writer, of a new "Collectors' Handbook" dealing with the collection and preservation of invertebrates other than insects. He wrote the section on Vermes in the "Standard Natural History" (1931), and articles on several groups of annelid worms in the Encyclopædia Britannica (14th edition). For about two years (1925–27) he was editor of the *Museums Journal.*

Soon after the outbreak of war, Monro's services were lent to the Ministry of Food, where he worked until his last illness. He had been seriously ill in 1935, and had undergone a severe operation. From that illness he had never completely recovered, and a second operation was performed a few weeks before his death. He possessed great charm of personality and a very open and upright character. He was a pleasant colleague and a good-natured companion, with a strong sense of humour and an acute and well-informed mind. Somewhat of a rebel, from his school days, against convention and what he considered social injustice, he was also interested in many aspects of learning and the arts, and was a man of very considerable culture and wide reading. He had a great love and understanding of poetry, and was deeply interested in theology and metaphysical philosophy. He always took a great delight in intellectual discussion, and many, no doubt, will remember a lecture delivered by him at a summer school at Cambridge in 1939 on the relation between science and religion. It seems to have been a desire to understand the deeper mysteries and problems of life that urged him to the study of biological science, and the same desire that led him, when already in his thirties, to embrace Catholicism, to which he was a fervent convert. He was keenly interested in the Neo-scholastic philosophy and in foreign politics, and was for a time honorary secretary of the Catholic Council for International Relations.

Until his health became seriously impaired, Monro had unbounded vitality and love of life, and of the good things it had to offer. His recreations included walking, swimming, yachting, fishing, shooting and fencing. For some years he was a leading exponent of the épée, being once runner-up in the British championship and one of the British representatives in a European tournament at Le Touquet. But above all he loved the open country and the hills, and most of his holidays were spent in walking in the Lake District, in Wales or in the west of Ireland. As a boy he had spent a number of holidays in France, acquiring a fluent knowledge of the French language, and an affection for the country and its people which he never lost.

Monro was twice married; first, in 1917, to Pamela Gartside Tipping, by whom he had one son (a captain in the Gordon Highlanders, missing at Singapore), and secondly, in 1927, to Sheila Mary Anderson, who, with their two young sons, survives him. H. A. BAYLIS.

DURING an acquaintance with Monro extending over some twenty years I have had, in common with many other zoologists, occasion to regard him with much gratitude, admiration and affection. In an era when good systematists are becoming lamentably scarce, Monro stood out as an example of the ideal systematic worker. His systematic knowledge of the Polychæta, in the first place, was wide, accurate and of an intelligent type, and coupled with the mass of detail at his finger-tips connected with the literature of the subject and the diagnostic features of the species contained in the group was a particularly useful acquaintance with their distribution and geographical relations.

Although dealing almost entirely with preserved material himself, Monro was always keenly interested in receiving news of the living animals and actively aware of the importance of their ecological relations. He was always thoroughly willing to assist ecologists by determining their material, and did it promptly and in the most helpful way. My personal gratitude to him was elicited by the assistance which he gave me in ecological work carried out during the Barrier Reef Expedition and during ten years of marine studies in South Africa. Among a group of systematists whose kind services made it possible to work out the results of these studies at all, Monro was outstanding as one of the most actively helpful: in fact, he was a member of that rather small class, the 'perfect systematists'. This was the more so because, as so many of his friends are aware, Monro was a personality of great liveliness apart from his official work altogether. Very widely read and capable of talking entertainingly and yet with balance on almost any subject, and possessed of abilities quite distinct from those required for his museum work, he was a very fully developed human being and a most welcome companion. T. A. STEPHENSON.

Prof. Joseph Paczoski

JOSEPH PACZOSKI, professor of the University of Poznan (Poland), who died on February 14, was a distinguished taxonomist and the founder of a new branch of botany, phytosociology. We do not know all the details concerning the last period of his life under German occupation in Poland; one can imagine, however, how much he must have suffered. At the beginning of the War in Poland, immediately after Poznan had been occupied by German troops, nearly all the university professors were arrested there, they were deprived of all their personal possessions, deported to the so-called General-Gouvernement and left to starve. This was also the fate of the 77-year-old Prof. Paczoski.

Joseph Paczoski was born on December 8, 1864, in Bialogrodka (Wolhynia). He was educated at the Agricultural School in Human (Ukraine) and afterwards studied and was assistant under the well-known Prof. Schmalhausen at the University of Kief (1888–94). He then held successively various posts. He was custodian of the Botanical Garden of St. Petersburg (1894–95), assistant at the Agricultural College of Dublany near Lwów (south-eastern Poland) (1895–97), director of the Natural History Museum at Cherson (Ukraine) (1907–20), founded by himself, director of the Steppes Preservation of Ascania Nova (1922–23). After the outbreak of revolution in Russia, Paczoski refused the very good facilities for scientific work offered him by the Soviet Government and left Russia for Poland. There he was appointed director of the National Park in Bialowieza (1923–28) consisting of primeval forest. At the same time he was professor of taxonomy and plant-geography at the University of Poznan. During about fifty strenuous years he published more than two hundred scientific papers and articles. These works have earned him a place among the best-known men of science in Europe.

When engaged in the study of the flora and of plant-geography he spent most of his time on excursions to many places ranging from the Baltic to the Adriatic Sea and eastwards to the Volga.

No other Polish botanist, and only a few from other countries, have succeeded in investigating such wide areas as Prof. Paczoski. He was considered to be the most outstanding investigator of the flora of south-eastern Europe. Prof. Paczoski was the originator of a new branch of botany, phytosociology. Until a few years ago men of science of western Europe had to refer in phytosociology to the treatise by M. R. Harper, "The New Science of Plant Sociology" (1917). Still more recently Russian botanists with their tremendous enthusiasm have occupied the first place in the development of phytosociology, after having rightly acknowledged the great merits of Prof. Paczoski, the Polish pioneer in this field (W. W. Alechin: "Wann und wo ist die Phytosoziologie entstanden?", Botaniska Notiser, Lund, 1924). It is more than fifty years since Prof. Paczoski published his work "Stages in Flora Evolution" (Russian, Wiestnik Jestiestwoznanja, St. Petersburg, 1891). There he laid down the principal outlines of phytosociology so clearly that to-day nothing more can be added or abstracted from these. The term 'phytosociology' was used for the first time in his next work "The Social Life of Plants" (published in the Polish magazine *Wszechswiat*, Warsaw, 1896). By giving the outlines of and a name to the new science Prof. Paczoski deserves a permanent place in the history of phytosociology. As acknowledgment of his great merits, the Polish Botanical Society reprinted his "Social Life of Plants" in the "Biblioteka Botaniczna", vol. 2, Cracow, 1930, published in Polish and English. The term 'phytosociology' has been used by the following authors in chronological order: J. Paczoski in 1896, P. Krylow in 1898, W. Sukaczew in 1915, M. Harper (United States) in 1917, in Scandinavia and Western Europe in 1919.

Researches made in Bialowieza directed his attention to the relation between the number of trees and diameter of the trees at 1·3 m. (to about 4 ft. 3 in.) in pure and mixed woods respectively. Paczoski's curves for the primeval and thinned forests are based on these measurements. These methods have been termed by Paczoski "biological structure of forests". After further investigation they will be of practical importance in forestry. Results have been published in the Polish Forestry Society's Journal *Sylwan* printed in Lwów, and in the standard work "Forest of Bialowieza". In 1930 Paczoski was sent by the University of Poznan to Yugoslavia and Bulgaria for special forest investigations. His very interesting results were published in *Sylwan*.

Prof. Paczoski's death is a serious loss not only to Polish science but also to the scientific community throughout the world.

S. B.

The Right Hon. Lord Glanely

THE RIGHT HON. LORD GLANELY, whose death occurred on June 28 as a result of enemy action, was president of the Court of Governors of the University College of South Wales and Monmouthshire. A Cardiff shipping magnate and head of the Tatem Shipping Company, he had always maintained a special interest in University College, Cardiff. After the War of 1914–18, when a special appeal was launched for the completion of the buildings on the new site in Cathays Park, he made a magnificent donation of £100,000 to that fund. This was allocated to the provision of the "Tatem Chemical Laboratory" and to the erection of a wing of the College to be devoted to the study of agriculture, a subject in which the late Lord Glanely was specially interested. This wing now houses the Advisory Departments of Agricultural Zoology, Agricultural Botany and Veterinary Science. In 1930 Lord Glanely made a gift of £2,000 to found two scholarships in memory of his wife, to be awarded in the first place to the children of parents who are or have been employed at or about Cardiff Docks. In this way he indicated his special interest in the welfare of the workers in the industry from which he derived his fortune. At the time of his death Lord Glanely was serving his third five-year term of office as president of University College, Cardiff. The College mourns the loss of a generous benefactor whose sympathy for, and interest in, its progress had extended over twenty-five years, the most difficult and important in its history.

WE regret to announce the following deaths:

Prof. Raymond Dodge, emeritus professor of psychology at Yale University, member of the U.S. National Academy of Sciences and president in 1916–17 of the American Psychological Association, on April 8, aged seventy-one.

Mr. E. C. Groesbeck, metallurgist of the Division of Metallurgy of the U.S. Bureau of Standards, on May 8, aged sixty-one.

Mr. G. C. Lloyd, secretary of the Iron and Steel Institute during 1908–34, on July 10, aged eighty-one.

Mr. W. F. Reynolds, chief of the Section of Triangulation of the Division of Geodesy of the U.S. Coast and Geodetic Survey, on May 1, aged sixty-one.

Prof. John Harrison Skinner, professor of animal husbandry and dean emeritus of the School of Agriculture of Purdue University, on April 28, aged sixty-eight.

Prof. A. N. Talbot, professor of municipal and sanitary engineering in the University of Illinois, on April 3.

Prof. W. H. Young, F.R.S., formerly professor of mathematics in the University of Wales, aged seventy-eight.

NEWS and VIEWS

National Institute of Agricultural Engineering

THE Institute for Research in Agricultural Engineering, University of Oxford, has been taken over by the Ministry of Agriculture to form the nucleus of a new national institute which has been established at Askham Bryan, near York. The general function of the National Institute of Agricultural Engineering will be to foster the development and better utilization of agricultural machinery of all kinds. Its work will be organized in three main departments. The Agricultural Department will provide a clearing-house for information about machines and methods for the benefit of both farmers and manufacturers; and will aim both at bringing equipment needs to light and at suggesting the means by which they can be met. The Engineering Department, which is to be adequately equipped with drawing office and workshops, will be concerned directly with design and improvement. In the case of new inventions, it will provide the necessary link between the original idea and the device which is ready for development, by undertaking the final stages of design and constructing prototype machines. The Field Station Department will be equipped to carry out whatever tests, trials or demonstrations may be required. One of its main duties during wartime will be to try out, adapt and demonstrate in other districts, labour-saving devices and methods which individual farmers up and down the country have worked out for themselves. The Institute will be guided in its work by the Agricultural Machinery Development Board, which was set up earlier in the year under the chairmanship of Lord Radnor. The director of the new Institute is Mr. S. J. Wright, formerly director at Oxford.

Planned City Growth

THE extent to which Mr. F. J. Osborn's admirable statement of the main essentials of planning, so far as they affect the ordinary citizen, originally written in 1918, is still valid to-day is a tribute to his powers of analysis and exposition (New Towns After the War. By F. J. Osborn. Revised edition. Pp. 72+8 plates. (London: J. M. Dent and Sons, Ltd., 1942. 4*s.* 6*d.* net.) It is also at least in part a reflection upon the general failure to apply those principles or even to learn from the bitter experience of the decade after the War of 1914–18. On both counts the 1942 edition deserves a warm welcome, and the new matter included, notably the illustration of the way in which Welwyn Garden City exemplifies the original thesis or formula, and the brief but well-chosen book list, enhance its value. The book is a concise re-statement of the argument for building new industrial towns, surrounded by country belts, as part of the reconstruction programme. Stressing the necessity for a national plan and criticizing the absence of policy which permitted the expansion of a few great cities at the expense of the countryside and of the smaller towns of Britain, with grave effects on the lives of town-dwellers and the efficiency of industry, it outlines broadly a policy commensurate with the needs of the time, the soundness of which is emphasized by the fulfilment of many of the author's predictions as to the trend of unplanned city-growth.

The close connexion of housing with public health, with transport, with problems of industrial and agricultural organization, with child welfare and education, national and local government and every aspect of the civic and cultural life of the community, leads Mr. Osborn to insist that there is a maximum size for a modern town. He advances the formula that a town should be of a population large enough to allow of efficient industrial organization and full social activity, but no larger. The urban area should be limited to a size requisite to house this population well, and should be surrounded by a zone of open land large enough to possess a distinctively rural and agricultural character. The whole of the land, including the urban area and the rural zone, should be owned and administered in the interest of the community. The application of this formula is well illustrated by reference to Welwyn Garden City, the foundation of which by Sir Ebenezer Howard in 1919 was an outcome of the original publication of the book. Mr. Osborn directs attention to the importance of some of the special problems involved, such as the location of new cities in relation to rural needs, some of which, like that of general control and liberty of individual taste in design, have not yet been fully thought out. The conditions of State support are indicated and Mr. Osborn gives an inspiring glimpse of the possibilities inherent in developments on these lines if the opportunities are used by creative minds alive to the social issues involved.

Dr. A. Yakubov

MELIK-PASHAYEV, chief geologist to the Azerbaidjan Oil Combine, has recently provided the Press Department of the Soviet Embassy in London with some interesting information concerning the career of Akhad Yakubov, vice-chairman of the Azerbaidjan Branch of the Academy of Sciences of the U.S.S.R. As a young man Yakubov's overriding aim was to master the science of geology and place his knowledge at the service of his country. More particularly was he concerned with the applications of geology to the economic exploitation of petroleum deposits. Experience as a technician in the oil fields of Baku and later at Lokbatan gave him a sure practical knowledge of the oil industry, which was implemented by his studies at Azerbaidjan Industrial Institute and at the Azerbaidjan branch of the Soviet Academy of Sciences, where he took his doctor's degree in geological and mineral sciences with honours. While in charge of oil extraction at a new field which was being developed on the slopes of Lokbatan mud volcano, Yakubov became convinced of the fallacy of the then widely held belief that mud volcanoes were incompatible with oil-bearing strata.

Detailed studies lasting over a period of ten years confirmed Yakubov in this view, and between 1934 and 1941 he published eight books elucidating the connexion between mud volcanoes and oil deposits. Summarily, Yakubov believes that "mud volcanoes are a direct indication of the existence of oil- and gas-bearing deposits" and that "the distribution of oil and gas is determined by the same laws as operate in regions where there are no mud volcanoes". His work considerably increases prospects of oil discovery in Azerbaidjan and is of immense practical value in the prosecution of the war against Germany. Early this year Yakubov was decorated with the Order of Lenin and afterwards was awarded a First Stalin Prize. Born in 1908, he is now at the height of his creative powers and plays a leading part in the scientific, political and public life of his country.

Bagasse for the Manufacture of Paper and Board

THE many attempts to utilize bagasse for the manufacture of paper have met with varying degrees of success, partly for economic reasons and partly because the nature of bagasse often renders it suitable only for relatively low-grade products. M. P. Bhargava and A. N. Nayer, of the Dehra Dun Forest Research Institute, have, however, recently approached the problem from the other extreme, namely, that of the manufacture of boards, and in particular of insulation and pressed boards, a large potential demand for which exists in India (*Imp. Council of Agric. Res., Misc. Bull.*, No. 44 ; 1941). The various processes available for the purpose were studied, but defibration in an Asplund-type machine was favoured on the grounds of the low installation and operating costs and of the quality of the product. The cost of afterwards rendering the boards resistant to moisture, fire and insects appears, however, to be disproportionately high. The samples accompanying the bulletin and the test data published in it suggest that, technically, the process is a promising one. The sample of bagasse wrapping-paper also sent is, however, less impressive ; no test data are given, but obviously the fibre length is short, which means low tearing and folding strengths.

A New X-Ray Photographic Paper

MESSRS. ILFORD, LTD., have recently placed on the market, under the name 'Kryptoscreen', a new X-ray paper incorporating its own intensifying screen. Underneath the sensitive emulsion is a layer of extremely fine white pigment which fluoresces under the influence of X-rays. The blue-violet light emitted shortens exposure times and much improves the gradation of radiographs made on the paper. The search for a cheap fluorescent material which neither lowers the sensitivity of the photographic emulsion nor impairs definition has been carried on for many years by the Ilford Research Laboratories. The resulting product provides an economical substitute for film in the radiography of fractures of the extremities and in certain types of industrial radiography. The same fluorescing material has been used to make a 'Brytex Intensifying Leaf' of exceedingly fine grain and medium intensification factor. When both screen and paper are used together, a reduction in exposure to one third of that needed by Kryptoscreen paper alone is possible without any loss of definition.

A New British Orchid

THE flora of the duneland area between Liverpool and Southport (botanically "south Lancashire", vice-county 59, but in all official and local nomenclature "west Lancashire") has always interested botanists well outside the local area owing to the many special forms of plants adapted to the peculiar habitat, and as a subject for plant ecology it much resembles the Flanders coast. Its list of sixteen Orchidaceæ is a special attraction and this has now been extended by the discovery and naming of a new species, *Epipactis pendula* (C. Thomas, *J. Bot.*, Dec., 1941) previously regarded by local botanists as *E. dunensis* (Godfrey, "British Orchidaceæ" ; Green, "Flora of Liverpool"), which in turn had for years been locally considered but an early-flowering variety of the common broad-leaved helleborine, *E. latifolia*, but with smaller, greener, less-expanded flowers. The new species was found and described in some numbers from Formby and appears to prefer the clearings by the woods, whereas *E. dunensis* proper is more typical of the open dunes.

In 1934 two Liverpool naturalists, Green and Hardy, made a floral survey of these dunes for Flora's League in the hope of creating a plant sanctuary, and this orchid was noted growing abundantly in and by the thinner pinewoods, but it was regarded as a woodland variation of *E. dunensis*. The description of the new species notes as characteristic its sturdy growth, small, opposite, arched and wavy-edged leaves, raceme of numerous pendulous flowers often tinted brown on the outside, flowers large and frequently wide open ; of forty-five plants at Formby a few had more than one flowering stem. The type is in the British Museum herbarium. If all the plants previously thought to be woodland forms of *E. dunensis* are the new species it seems safe from extermination, and was possibly evolved from *E. dunensis* since this coastal area was afforested in 1889.

Ultra-violet Radiation

A SUMMARY of the uses of ultra-violet radiation with special reference to lethal effects is given by J. R. Harris in the *Electrician* of July 10. The 'near' ultra-violet region, 3,200 A. to 4,000 A., is used for photographic and fluorescent effects, the source generally being the ultra-violet 'black' lamp, which emits a maximum radiation at 3,650 A. The 'middle' band, 2,800 A. to 3,200 A., represents the therapeutical region which produces erythema ; lamps emitting this radiation are the so-called sunlamps and are widely used as a tonic treatment in welfare centres. Rays in the 'far' ultra-violet region, 2,000 A. to 2,800 A., are lethal to bacteria; the most suitable source is the quartz mercury-vapour discharge lamp large numbers of which are used in the United States for sterilizing.

The lamps have been given the following applications. Germicidal lamps have been installed in air-ducts, particularly those of air-conditioning schemes. In the ward of a children's hospital, germicidal lamps have been placed in concentrating reflectors and mounted on the ceiling between the cots to prevent the free passage of bacteria by the presence of the invisible 'lethal' curtain. Lamps have been installed with successful results in a mattress factory for sterilizing the cotton, the method proving cheaper than sterilizing by placing the cotton in a room containing formaldehyde fumes. A New York hotel recently purchased a specially constructed unit of four 15-watt germicidal lamps for use in bathrooms, the whole unit being designed so that the ultra-violet rays reach the floor and walls; the lethal efficiency is stated to be 99 per cent. Small sources have been installed over the counter of a bank so as to produce an invisible 'purification wall' between cashiers and customers.

A New Circuit Continuity Test

A. F. BURNS, in an article on testing of the crossbar system of telephony (*Bell Lab. Rec.*, **20**, No. 9 ; May, 1942), points out that in dialling systems a talking connexion is established through a large number of contacts, and it is desirable to test for ensuring that after the circuit is closed through to the called subscriber, there will be no open circuits in the offices through which the call passes. With the crossbar system, the sender makes a continuity test t the calling office and at the originating office, but it was found to be impracticable to provide a suitable outine testing procedure for the terminating office because of the multiplicity of paths that any paricular call might follow. It was decided, therefore, o arrange the terminating marker to apply a coninuity test for each call to make sure, before it is disconnected, that a circuit is completed to a subscriber line.

Briefly, the method consists in sending grounded 20-cycle current through the central-office contacts, out on one side of the subscriber line, through the station ringer, or signal, and to ground either at the subscriber station or at the central office. The difficulty associated with widely varying circuit capacitances and resistances was overcome by taking advantage of the difference in phase between the current flowing through the office capacitance and that flowing over the subscriber line, which latter is chiefly resistive under extreme conditions. In the extreme case, when the ground capacitance is zero and the circuit is closed, the current that flows is in phase with the applied voltage, whereas when the capacitance from the 20-cycle supply to ground is a maximum and the circuit is open, the current flowing is 90° out of phase with the applied voltage. An open circuit with high leakage may thus draw more current than a closed circuit with low leakage, but the angular displacements of the currents with respect to the applied voltage are very different. The new test is based upon this fact, and current flowing in the test circuit is determined from the voltage drop across a condenser in series with the subscriber line. The article describes the test circuits and apparatus in detail and indicates the criteria governing the test.

Philosophy in the *Philosophical Magazine*

ALTHOUGH physics is regarded as one of the exact sciences, exactitude was not always found in the titles of its journals. For many years *Science Abstracts* was regarded as an adequate title for the journal now known as *Physics Abstracts*, and the *London, Edinburgh and Dublin Philosophical Magazine and Journal of Science* has published many more papers in physics than in philosophy. In the May number of the latter, however, four of the seven papers are mainly philosophical. Prof. E. T. Whittaker gives a stimulating discussion of "Some Disputed Questions in the Philosophy of the Physical Sciences", using well-chosen analogies. Attention is naturally given to the attempts of mathematicians to discover 'facts' without the use of experiment or observation. As mathematical symbols are not used, the paper is suitable also for the general reader. The other three papers deal with the thorny subject of dimensions. In a brief note, Dr. Norman Campbell points out that writers on the subject are apt to ignore much of the vast literature because "anyone who attempted to summarize the literature would become involved in so many controversies that he could get no further". Since assignment of dimensions is a means to an end, and not an end in itself, writers are urged to state explicitly what end they have in view and how that end is served by the considerations presented in their writings. In a paper of twenty-four pages, Prof. H. Dingle attempts to relate the subject to more fundamental and universally acceptable ideas. Twelve definitions and postulates are given as a set of principles upon which discussion of dimensions may be based. The third paper, by Dr. G. B. Brown, is a reply to some criticisms of Prof. Wilson upon a recent paper on dimensions published originally in the *Proceedings of the Physical Society*, **53**, 418 (1941).

Potentialities of the Forests of Latin America

PROF. S. J. RECORD of the School of Forestry, Yale University, raises the question of the utilization of the "enormous areas" of potentially commercial forest in Latin America in a brief article in *Tropical Woods* (No. 70. Yale University; June, 1942) that deserves wide consideration. He points out the reasons for the lack of demand for tropical lumber. Tropical timbers are different from those growing in the north temperate zone; they may not be inferior but their technical properties are unknown to the consumer. Private commercial concerns naturally do not face the trouble and expense involved in trying out the utility of the new wood for their purpose and they have no guarantee of continuity of supply of the new type. The plain lack is that of subsidized laboratory facilities to make pilot tests on the utility of available timber, to trace defects in supply to their source, to encourage good forestry management and exploitation and to educate the trade in the utilization of the new wood in manufacturing processes. Prof. Record concludes: "Science and Engineering together can find a way to use the tropical forest as a whole and make it a perpetual source, not only of plywood and lumber, but also of unlimited quantities of cellulose, a basic material with a myriad actual and potential applications in industry."

Discovery of the North American Flora

MANY kinds of trees and shrubs now used in forestry and gardening owe their introduction to the pioneer journeys of David Douglas (1799–1834). These early botanical explorations form the subject of a recent paper by F. R. S. Balfour (*J. Roy. Hort. Soc.*, **67**, Parts 4 and 5; April and May, 1942). Douglas's journey to the North Pacific Coast in 1824 was backed by the Royal Horticultural Society, and resulted in the introduction of such garden favourites as *Ribes sanguineum* and *Berberis aquifolium*. New conifers were later discovered, namely, *Pinus nobilis*, *P. amabilis*, *P. lambestiana*, *Larix occidentalis*, *Thuja plicata* and many others. Neither shipwreck nor illness deterred this intrepid botanist, and while most of his journeys were made in North America, he met a rather strange death during a journey in Hawaii.

Cancer Control

AN annotation in the *Journal of the American Medical Association* of April 18 states that since a cancer control programme was inaugurated fifteen years ago in Massachusetts, about 14,000 patients with cancer, 40 per cent of whom are still alive, have attended the special clinics for the disease. 80·8 per cent of the patients were referred by medical practitioners to the clinics as compared with only 20·1 per cent in the first year of the programme. Between 1927 and 1935, 421 medical men used the tumour diagnostic service as compared with 798 in 1940. As regards the education of the public, the delay between the time of the first recognized symptom of the disease and the time that the patient obtained medical advice averaged 6·5 months in the early years of the programme, whereas between 1936 and 1939 it was 5·3 months and in 1940 4·6 months. In 1932, 31·1 per cent of the fatal cases had never been treated in a cancer hospital, while in 1940 this figure was reduced to 15·6 per cent, indicating that hospitalization for cancer is increasing far more rapidly than cases of the disease.

Biology in Brazil

We welcome the appearance of No. 1 (March, 1942) of Vol. 2 of the *Revista Brasileira de Biologia*, the official organ of the Biological Society of Brazil. The issue runs to 133 pages and contains seventeen papers covering a very wide field of biological subjects including medicine and parasitology. Thus, P. W. Wygodzinsky describes new species of insects of the orders Diplura and Thysanura from Palestine: J. R. Valle and P. R. Souza discuss observations concerning the endocrine system of eighty-four ovoviviparous snakes, and especially the corpora lutea; and F. Feigl and H. Cardoso write on tests for the identification of ascorbic acid. Each volume of the journal is to contain about five hundred pages, comprised in four parts issued in March, June, September and December. The subscription outside Brazil is 4 U.S. dollars, which should be sent to the Secretario da Comissâo de Redaçâo, Mario Vianna Dias, Caixa postal 1.587, Rio de Janeiro, D.F., Brazil.

Health of Ceylon

According to the report of the Director of Medical and Sanitary Services, Ceylon, in 1940, malaria, as in previous years, was the most prevalent disease in the island, about 97,000 cases having been treated in hospitals and 2,994,000 in dispensaries. The chief outbreak occurred in the south-west early in May and continued until the middle of July. In the north-western province an epidemic of dysentery, due to the Shiga bacillus, also started in May. During the year the leprosy survey which was begun in 1933 was completed. The total number of patients was 2,771—2,032 males and 739 females—of whom more than a thousand were segregated in two leper asylums. The whole population of Ceylon is estimated at 5,951,000, The total births in 1940 numbered 212,982, a rate of 35·8 per 1,000; deaths amounted to 122,738, a rate of 20·6. The infant mortality-rate was 149 per 1,000 and the maternal rate 16·1.

Aphids

A short paper by G. Fox-Wilson (*J. Roy. Hort. Soc.*, **67**, Pt. 6; June, 1942) reviews the horticultural significance and control of aphids. Eradication of these pests is often difficult, and one of the reasons is discussed in the paper. Viviparous stem mothers, when subjected to certain contact insecticides, often remain in a comatose state before death actually occurs, but living nymphs are often produced in this condition. Spraying with nicotine is the best control, but Derris and Pyrethrum washes should be employed where the plant parts attacked are to be used for food.

Physics Bibliography

The vital importance of the library as a part of the equipment of a research laboratory is implicitly acknowledged in the *Review of Scientific Instruments* by the attention given to the current literature of physics in each number of the journal. Twice a year special book numbers are issued, and the spring book number (13, No. 4, April, 1942) contains twenty four pages devoted to reviews of thirty-eight books on physics. In addition, a two-page "Condensed Library Guide for the Physicist" gives a summary of the standard sources of reference. Copies of the list for the use of students can be bought in quantity from the American Institute of Physics, 175 Fifth Avenue, New York. The list serves as a reminder of the extent to which physics lags behind chemistry in bibliography. The usual monthly survey, "Current Literature of Physics", deals with the research journals. The latest reference to an English journal appears to be that to the issue of Nature dated February 7.

Announcements

In pursuance of the decision of the Secretary of State for the Colonies to open the administrative service in the Gold Coast to Africans, Mr. K. A. Busia and Mr. A. L. Adu have been selected as assistant district commissioners in the Gold Coast. Mr. Busia, an Ashanti, was born in 1913. He was educated in the Gold Coast, where he graduated in 1939, and at University College, Oxford, where he obtained a B.A. degree. Mr. Adu, a member of the Twi tribe, was born in 1914. He attended schools in the Gold Coast, and afterwards went to Queens' College, Cambridge, where he took a degree in natural science.

The following have been elected to fill vacancies which will occur on the Council of the Institution of Electrical Engineers on September 30 next: *President*, Prof. C. L. Fortescue; *Vice-President*, Mr. P. Good; *Hon. Treasurer*, Mr. E. Leete; *Ordinary Members of Council*, Prof. J. D. Cockcroft, Mr. A. J. Gill, Mr. D. B. Hoseason, Dr. A. H. Railing, Mr. E. A. Reynolds, Mr. H. W. H. Richards, Mr. J. M. Fleming and Mr. C. W. Bridgen.

An extensive list of institutions, societies and research workers in the pure and applied plant sciences in Central and South America has been prepared by the editors of *Chronica Botanica*, in co-operation with the Division of Agriculture of the Office of the Co-ordinator of Inter-American Affairs, Washington, D.C. The list has been published in *Chronica Botanica*, **7**, No. 2 and 3, March and May, 1942 (*Chronica Botanica* Co., Waltham, Mass.). There are about two thousand names in the list, which is the first of its kind.

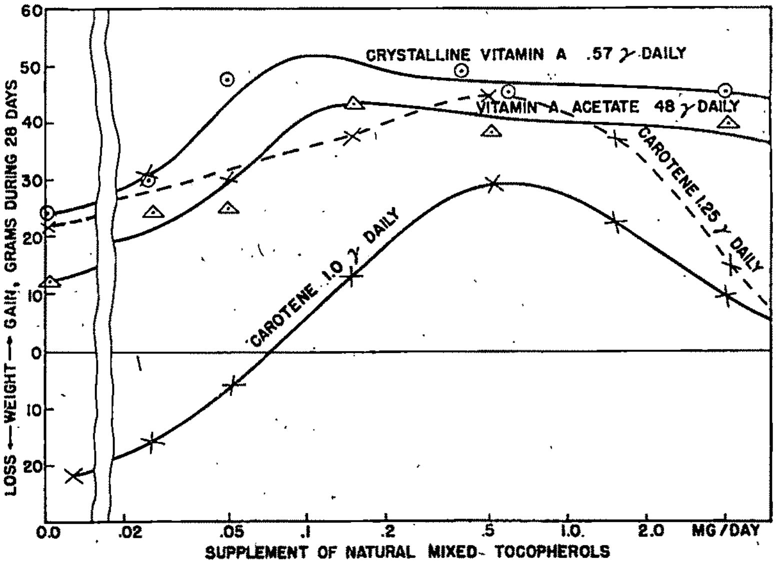
Schuman's, of 20 East 70th Street, New York, have issued a catalogue entitled "Medical Miscellany List E". Attention may be directed to the following items: the "Compendium Artis Medicæ" of Bertucius *alias* Bertuccio or Bertrutius (1537), the "Libri duodecim" of Alexander of Tralles (1556), the "Opuscula anatomica" of Eustachius (1563–64), the first edition of John Hunter's "Treatise on the Venereal Disease" (1786), Morgagni's "De Sedibus et causis morborum" (1820–23), and various early works on anæsthesia. A section on military medicine contains notice of the following important works: George James Guthrie's "Commentaries on the Surgery of the War in Portugal, Spain, France and the Netherlands" (1862), Woodward's "Report on Epidemic Cholera, and Yellow Fever in the Army of the United States during the year 1867" (1868), George M. Sternberg's "Sanitary Lessons of the Spanish-American War" (1899), and Cabanès's "Chirurgiens et blessés à travers l'histoire" (1918).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Interrelationship of Vitamins A and E

THE effect of vitamin E in preserving vitamin A n oil solution[1] and increasing the store of vitamin A n the liver of the rat[2] suggests that there is an interependence of the two vitamins which hould become apparent in other ways. The failure of Bacharach[3] o confirm all Moore's work on liver torage may be due to differences in ondition and relative quantities mployed, Moore approximating nd Bacharach missing the optinum effect. Using the United tates Pharmacopeia vitamin A ssay method (with olive oil as the pecified "vegetable" oil in the basal iet) and *fixed* quantities of vitamin A, we have examined the effect of itamin E over a *wide* range of osage on the growth of young rats epleted of vitamin A. Some of he results are summarized in the ccompanying graph.



Three forms of vitamin A were chosen: the pure crystalline alcohol, a crystalline ester acetate), and mixed carotenes 90 per cent β-, 10 per cent α-). he vitamin E was a molecular istillate containing 40 per cent of mixed tocopherols,

$$\left\{ \frac{E^{1\text{ per cent}}_{1\text{ cm. }295\text{ m}\mu}}{0\cdot8} = \text{per cent tocopherols} \right\}.$$

The synergistic effect is pronounced, that with arotene striking—a quantity which was unable to upport life alone, inducing good growth when fed ith sufficient vitamin E. The optimum supplement f tocopherols, which is not at all critical, ranges rom 0·1 mgm. daily for vitamin A to 0·5 mgm. for arotene, or about 0·6–3·0 mgm. daily per kgm. of ody weight. The mutual effect persists with high evels of A intake and is most apparent when the itamins are fed simultaneously. Feeding vitamins A and E on alternate days, or giving vitamin E uring the preliminary A-depletion period, seems to iminish the effect.

Benzene extracts of the fæces of rats or humans how a small positive reaction to the Furter-Meyer nd Emmerie-Engel tests. After ingestion of tocoherols, the titres are increased in excess of the uantities fed, though only part of the vitamin E ctivity is recoverable by bio-test. This suggests hat the tocopherols have decreased the oxidation of he lipids in the G.I. tract. Considered with the data n alternate days of feeding, it is concluded that the rst function of vitamin E is to preserve the vitamin A efore and perhaps during intestinal absorption. A econdary effect is the preservation of vitamin A at he site of utilization in the body. Clausen[4] has hown that the transfer of vitamin A to the fœtus om the mother during pregnancy occurs chiefly hrough the medium of carotene. One effect of itamin E deficiency may be the lowering of blood rotene levels in the pregnant rat below that compatible with life of the fœtus. Consequently, the anti-sterility test may be influenced by the administration of carotene and perhaps by vitamin A. A preliminary assay has furnished the following data:

Mixed tocopherols fed*	Vitamin supplement fed	Litter efficiency
1·36 mgm.	None	14 per cent
,,	,,	0 ,,
,,	Vitamin A 100 γ	14 ,,
,,	β-Carotene 300 γ	43 ,,

* In the laboratory where this assay was performed, a dose of 1·0 mgm. synthetic α-tocopherol is considered necessary to give a 50 per cent litter efficiency.

In the case of the rat on the sub-optimal A–E diet, the generalization may be hazarded that an acute shortage of either vitamin will involve deficiency symptoms of the other. Indeed, if a general function of vitamin E in animal nutrition is that of intestinal antioxidant, vitamin A may not be the only labile substance rendered more available to the body. Clinical evidence of moderate E deficiency may well be manifested in apparently unrelated deficiency symptoms.

It would seem necessary to modify the accepted methods of bio-assay of the two vitamins, retention of β-carotene as the international standard of vitamin A, becoming something of a farce. A comparison of United States Pharmacopeia Reference Oil II with carotene could, by suitable juggling of the E content of the diet, show apparent potencies anywhere from 700 to 4,000 international units, the difference between the two scales becoming unimportant.

It would also seem desirable to follow the A–E synergy with animals other than rats. Studies under way with mink and related fur-bearing animals are so far positive. Should the effect be found significant with farm animals and humans, the question of preserving or supplementing vitamin E in feed will rank in importance with retaining carotene or adding vitamin A. In human nutrition the doubts as to whether a well-balanced diet can supply optimal amounts of vitamin A can be relieved by attention to the vitamin E content. Judged solely from our experiments with rats, the optimal human intake would be 50–200 mgm. mixed tocopherols daily. It seems unlikely that the diet—especially the war-restricted diet—contains these quantities. A supplement of 50 mgm. would provide a total intake not far from the optimum.

The above work, to be reported fully elsewhere, is being repeated with the three pure tocopherols and extended to other animals than rats—of which, to date, about 1,500 have been used without encountering assays at variance with a positive A–E synergy.

K. C. D. HICKMAN.
P. L. HARRIS.
M. R. WOODSIDE.

(Communication No. 39)
Distillation Products, Inc.,
Rochester, New York, U.S.A.

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[1] Unpublished data.

[2] Moore, T., *Biochem. J.* **34**, 1321 (1940); Davies, A. W., and Moore, T., NATURE, **147**, 794 (1941).

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Parsley as a Rich Source of Vitamin C

IT has been pointed out by Widdowson and Allington[1] that the present restriction of citrus and other fruits in the diet of the middle classes has not been compensated for by an increase in the amount of vegetables eaten, therefore the vitamin C intake has been reduced to half that consumed by the same families in 1935.

Bourne[2] has pointed out the seriousness of the situation that would arise in the event of a failure of the potato crop; although he thinks this improbable. There is no doubt that a very large percentage of the working-class population rely for their source of vitamin C upon the boiled potato, so that a partial failure of the crop with consequent local shortages would reduce the vitamin C intake to a dangerously low level.

While perhaps frank scurvy would not make its appearance, the increased liability to infection when the diet was low in vitamin C might lead to a very serious loss of working hours by workers on essential war work, especially in an epidemic.

It seems to me, that if the population cannot be induced to increase their consumption of green vegetables, the replacement of these and citrus fruits by something in the diet with a very high content of vitamin C is of importance in safeguarding the health of the public.

Apart from the pure crystalline vitamin, the choice should be something which is available, or could be made available, all the year round, and which could be easily grown by a very large percentage of the population, and, still more to the point, something with which they are familiar.

The high figure of 280 mgm. per 100 gm. has been recorded for parsley grown in India[3], 196 in South Africa[4] and 176 and 180 in America[5]. The ascorbic acid content for picked leaves of parsley grown in Cambridgeshire is shown in Table 1. The leaves were ground and extracted with trichloroacetic and metaphosphoric acid, and quickly titrated with 2 : 6-dichloro-phenol-indophenol, using the micro method of Birch, Harris and Ray[6]. Reduction by hydrogen sulphide showed no increase, and treatment by mercuric acetate[7] no decrease, in the figures obtained by direct titration.

It will be seen from Table 1 that the average of 279·5 mgm. of ascorbic acid per 100 gm. for nine different samples of English parsley is somewhat higher than the averages given by Olliver[8] for ripe black currants, and places it in the front rank antiscorbutics. Although no biological assay has be done, Harris and Olliver[9] have confirmed the agre ment between results obtained by this chemic titration method and in biological assays. It remai to be seen whether there are seasonal variations, a if the age of the leaves or the richness of the s influences the content of the vitamin.

TABLE 1.

Date	Ascorbic acid (mgm. per 100 gm.)	Ascorbic acid (mgm. per oz.)	Water (per cent)
1942			
April 13	307·68	87·05	78·66
,, 14	250·00	70·80	77·52
,, 16	250·00	70·80	83·08
,, 17	266·40	75·55	81·08
,, 28	275·84	78·22	82·40
May 1	291·20	82·59	78·42
,, 4	291·20	82·59	80·74
,, 4	333·28	97·54	78·96
June 7	250·00	70·80	80·96
Average	279·51	79·54	80·20
Stalks April 14	66·40	18·83	85·14

The optimum amount of ascorbic acid required an adult weighing 70 kgm. (11 stone) is abo 60 mgm. a day[10], while half this amount will prote against any manifestations of scurvy[11]. It follow therefore, that ½ oz. of parsley eaten a day will gi complete protection with a diet lacking the vitami Unfortunately parsley is very bulky for its weigh ½ oz. of picked leaves is a small handful, but diminished to a heaped tablespoonful by choppin

It would be better to encourage the eating of t small picked leaves, and so preserve all the vitamin but if the parsley is not chopped wet, and a sha stainless steel knife is used, the loss is only of the ord of 20 per cent, and there is still enough vitamin le in ½ oz. for protection. The vitamin is irreversib oxidized by the oxidases at the cut surfaces, so t finer the parsley is chopped the greater will be t loss. After the initial loss there is no further decrea upon keeping for three hours. This has also be shown for cabbage by Pyke[12] and confirmed Lampitt *et al.*[13].

TABLE 2.

Time after chopping	Original ascorbic acid content (mgm. per 100 gm.)	Ascorbic content after chopping (mgm. per 100 gm.)	Loss per 100 gm.
30 min.	250·00	200·00	20·0
30 ,,	250·00	210·48	15·8
30 ,,	275·84	222·00	19·5
3 hr. 0 min.	275·84	222·00*	19·5

* This sample reduced by hydrogen sulphide showed no increase

With the growing trend to desiccate foodstuffs wi a presumable loss of vitamin C, these results ne emphasis. It should also be remembered that parsl is very rich in iron, containing 1·42 mgm. of availa iron per oz.[14].

The crop production could easily be increased, f parsley can be grown by anyone with a garden allotment. It is not unsightly as an edging to flower border.

If the population could be induced to grow mo parsley and include it in their diet, it would be of great benefit to their health, and also a wise step to take. If there were a shortage of potatoes, parsley would act as a valuable source of vitamin C served with a small ration of boiled potatoes.

There are many culinary uses for parsley, and instead of the usual 'sprinkling', much more could be used. More use could also be made of it alone, or with meat, meat pastes or 'Marmite' in sandwiches. It is best to use it naturally, fresh from the garden; but in order to keep it ready for use, it should be washed, shaken to remove water and kept with the stems in water. I found no loss of the vitamin after keeping in this way for two days.

One of the best ways to use it for replacing citrus fruits is to make 'parsley lemonade' in the following simple way. Take 1 oz. of picked leaves (two handfuls) and press down in a jug; pour on to this ½ pint of boiling water and allow to stand two minutes. Now strain through a piece of muslin (or calico) and get all the parsley into the muslin, squeeze out all the liquid you can, and cool. The extract is slightly cloudy, lemon yellow in colour and contains 40–56 mgm. of ascorbic acid. This is equivalent in its vitamin content to the juice from an orange of average size. The vitamin content can be increased by using up to 2 oz. of parsley to ½ pint of water. A clear extract is obtained if the parsley is not squeezed, but it contains only about half the amount of ascorbic acid. It is not unpleasant to the palate, since there is only a slight flavour of parsley. If desired, it can be flavoured in a variety of ways to suit the taste, such as by using a lemonade preparation which has not been made from lemons.

Some typical figures obtained from 1 oz. of parsley by squeezing were 43·08, 56·80 and 51·64 mgm., and by straining only, 27·54 and 26·66 mgm.

I suggest that more parsley be used in preparing snacks and meals in canteens, British Restaurants, schools, etc.

E. J. MORGAN.

Biochemical Laboratory,
Cambridge.

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Proliferation-promoting Activities of Extracts from Ultra-violet Injured Yeast Cells and of Bios Components

NUMEROUS papers from these laboratories have dealt with the production of proliferation-promoting factors ('intercellular wound hormones') by cells subjected to various injuring agents. It seems warranted to believe that these substances are produced by living, injured cells as a response to injury and are not simply dead-cell disintegration products[1]. The question of the nature of these materials is of great interest. It might be assumed that they are merely normal growth substances produced or released in greater quantities under the conditions of injury, or it is possible that they represent specific 'injury substances'. Two lines of inquiry have been undertaken to answer the question: (1) chemical and spectrographic studies, which suggest a nucleic acid-like nature for the wound hormones and which definitely show that substances of this type are produced in greater quantity as a result of injury[2]; (2) comparative growth studies, on the wound hormone preparations and known growth substances. The present note is concerned with the latter.

In the earlier work assays for proliferation-promoting activity of wound hormone preparations on yeast were carried out in Reader's medium[3], an incomplete medium as judged by present standards. In experiments to be published in detail elsewhere[4] a wound hormone preparation (prepared by the full ultra-violet irradiation of a suspension of 917 gm. of Fleischmann's bakers' yeast in 10 litres of 0·85 per cent sodium chloride solution for twenty-seven hours; details in paper cited) was assayed for its effect on the proliferation of a strain of *Saccharomyces cerevisiœ*, isolated from Fleischmann's bakers' yeast, in the following media: (1) Reader's; (2) Reader's plus a bios supplement; (3) Reader's plus a bios supplement plus twenty amino acids; (4) Williams's[5]; (5) Williams's plus bios; (6) Williams's plus bios plus amino acids. The bios supplement consisted of inositol, 100 γ per c.c.; thiamin hydrochloride, 0·8 γ per c.c.; biotin, 0·002 γ per c.c.; calcium (+) pantothenate, 0·12 γ per c.c.; vitamin B_6 hydrochloride, 0·8 γ per c.c. The amino acids were asparagine, alanine, arginine, aspartic acid, cystine, glutamic acid, glycine, histidine, hydroxyproline, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophane, tyrosine and valine, each in concentrations of from 0·06 to 0·48 mgm. per c.c.

Media (3), (5) and (6) gave the best growth, which represented about a 1,100 per cent increase over that in Reader's medium. The similarity of growth in media (5) and (6) is apparently due to the inclusion of asparagine in Williams's medium. The beneficial effects of the bios components and amino acids were thus quite evident. Addition of the crude wound hormone preparations in every case gave increased growth, showing that, while part of the activity of the wound hormone preparation is no doubt due to the known bios factors, a definite residual activity is due to factors other than these. This increased growth effect of the wound hormone was detectable in concentrations of the crude preparation as low as 0·5 γ per c.c.

We have now had an opportunity to extend these observations somewhat. Indications are that a large portion of the amino acid effect is due to asparagine, and we have found that the mixture of the twenty amino acids can be replaced with almost complete satisfaction by the six amino acids: arginine, asparagine, aspartic acid, glutamic acid, leucine and lysine. We have further supplemented the media with the following (in γ per c.c.): riboflavin, 1; uracil, 1; choline hydrochloride, 1·5; acetyl choline bromide, 1; ethanolamine, 5; nicotinic acid, 5. The addition of these substances seems to have no, or relatively slight, effect on the growth of our strain of yeast and they do not lessen the activity of the wound hormone preparation. Addition of ρ-aminobenzoic acid in concentrations of 2·5 to 10 γ per c.c. did not increase the yeast crop and, in some concentrations, gave a suggestion of slight inhibition, which may not be significant.

The work may be summarized as follows: Cell-free wound hormone preparations from ultra-violet injured yeast cells maintain a considerable degree of their proliferation-promoting potency for yeast in media containing not only the required inorganic constituents and sugar but also containing amino acids, inositol, thiamin, pantothenic acid, biotin, vitamin B_6, riboflavin, uracil, choline, acetyl choline, ethanolanine, nicotinic acid and ρ-aminobenzoic acid. The wound hormone preparation therefore contains active substances in addition to these.

Elton S. Cook.
Sister Ann Gertrude Cronin, S.C.

Institutum Divi Thomæ,
Cincinnati, Ohio.
June 10.

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Bacterial Reduction of Tetrathionate

The power of reducing nitrate is widespread among micro-organisms, while the reduction of sulphate is restricted to a few species[1]. It has long been recognized, however, that many bacteria are able to reduce less highly oxidized inorganic sulphur compounds (tetrathionate, thiosulphate, sulphite, etc.) to hydrogen sulphide[2]. In the course of attempts to improve selective media for isolating Salmonellas and *Bact. typhosum* from excreta, we have found that, so far as some organisms are concerned, the tetrathionate is first reduced to thiosulphate. This reaction takes place rapidly and quantitatively, and estimations at different stages show that the molecular concentration of the thiosulphate formed is twice that of the tetrathionate which has disappeared, in agreement with the equation:

$$Na_2S_4O_6 + 2H \rightarrow Na_2S_2O_3 + H_2S_2O_3.$$

The subsequent further reduction of thiosulphate to hydrogen sulphide is, in comparison, so slow that the reduction of tetrathionate can be followed accurately by direct iodometric titration of the thiosulphate, provided that the high acidity developing from accumulation of thiosulphuric acid is controlled by a phosphate buffer.

The ability to reduce tetrathionate is possessed by most of the common Salmonellas, such as *Bact. typhosum, paratyphosum B* and *C, typhi-murium, thompson, reading* and *dublin*, and by members of the Proteus group, but not by most other fæcal organisms tested including *Bact. coli, Bact. aerogenes* and dysentery bacilli.

Our experiments have been done almost entirely with *Bact. paratyphosum B*. The reaction can be followed in growing broth cultures, or by the use of thick washed suspensions. Unless, however, some suitable hydrogen donator such as mannitol or glucose is added to the washed suspensions, the reaction proceeds comparatively slowly. When prepared from organisms grown on plain nutrient agar, washed suspensions show an apparent lag phase before the rapid reduction of tetrathionate begins. This lag phase is not present when the organisms have been grown on agar containing tetrathionate. Suspensions grown on plain agar can be 'adapted' to reduce tetrathionate without the initial lag phase by incubation for only three or four hours with tetrathionate and mannitol without additional source of nitrogen.

The reaction appears to be similar to other known types of anaerobic oxidation processes[3] and we have evidence that it involves a hydrogen donator (for example, glucose or mannitol), a specific dehydrogenase, a heat-stable co-enzyme-like factor present in tryptic digest broth and acting as a hydrogen carrier, a reducing enzyme mechanism, and a hydrogen acceptor (tetrathionate). The 'adaptive' effect mentioned above, taken in conjunction with the fact that tetrathionate reduction is restricted to certain organisms, strongly suggests a true acceptor specificity.

The discovery of this system is of interest from several points of view:

(1) It has brought to light certain facts of obvious importance in any attempt to explain the selective action of tetrathionate in media for isolating Salmonellas, etc.

It is significant that, in general, organisms which actively reduce tetrathionate are able to grow well in media containing it in relatively high concentration, and that, in competitive growth such as occurs in cultures from fæces, tetrathionate selects those organisms which can reduce it. The reason may be partly that the ability to reduce tetrathionate provides these with a mechanism of energy release not available to other organisms. Further, it is of interest that the substance produced in the bacterial reduction of tetrathionate is thiosulphate, which can be shown to be much less toxic than the tetrathionate from which it is formed. It is not clear, however, whether in mixed cultures this would operate entirely in favour of the tetrathionate reducers.

(2) It provides an interesting example of an oxidation mechanism of a kind known to be present in facultative anærobes[4], and especially likely to be of value to tetrathionate reducers under conditions of low oxygen tension.

(3) It affords an opportunity of investigating the important questions of acceptor specificity and enzyme adaptivity.

(4) The simple titration technique, though limited in application, is an accurate and convenient method for the study of enzyme kinetics.

It is intended to publish shortly a fuller account of this work.

M. R. Pollock.
R. Knox.
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THE GAS INDUSTRY IN GREAT BRITAIN AFTER THE WAR

THE Institution of Gas Engineers held its seventy-ninth annual meeting in London on June 10, under the presidency of Sir Frederick J. West, of Manchester. The main business was the discussion of six short papers dealing with the place of the gas industry in meeting the post-war needs of Great Britain. Throughout the papers ran an emphasis on the need for greater and more thorough education of the personnel of the industry under the conditions of the future. Prof. D. T. A. Townend reviewed the development of university education since the industry applied the Livesey Fund in 1910 to endow a chair in coal gas and fuel industries in the University of Leeds. Recently the University has extended and widened the curriculum by incorporating courses in chemical engineering.

Mr. E. V. Evans, of London, vice-president, gave an account of the progress and intentions of the Gas Research Board established shortly before the outbreak of war. The gas industry of Great Britain can claim a long and effective experience in sponsoring co-operative investigations for the common good, but on a scale which was long felt to be inadequate to meet present and future needs. The new Board was devised to provide for great and necessary developments, but for obvious reasons these have been hindered by the War. Much of what has been done is of a nature which precludes publication.

To-day the most important technical question before the gas industry is the choice between carbonization and complete gasification of coal. In the future, will coal be carbonized in retorts to yield both gas and coke, or will the main product be gas only and no coke ? The possibility of complete gasification of coal under pressure has been shown to be technically possible, but it remains to be shown to be commercially feasible. Success is of great national importance. The industry would be free to use almost any class of coal, free to control the amount of coke produced, and independent of imported mineral oil for the enrichment of water gas. The War has delayed the search for the answer to this problem, and much depends on the answer.

If it is shown possible to convert coal into a suitable gas without coke residue and at an acceptable price, then consumers might reach the fortunate position of those in countries with supplies of natural gas. If this quest is unsuccessful, then the industry must organize itself to supply a combination of gas and coke. The industry has already gone far to inform itself of the size of the problem. In London it has been shown from fuel bills that householders of low purchasing power need 274 therms of 'useful' heat, that is, gross heat in fuel consumed with a correction for efficiency of utilization. Mr. E. Crowther, of Newcastle, in a paper advocating the use of gas for supplying all the heat needs of householders, recorded experience with many houses specially designed and equipped for the purpose. Fuel bills show that in Newcastle the corresponding figure is 316 'useful' therms. With the tariff charges applied the total costs were of the same order as those found when the dwellings were heated by older methods.

Dr. Harold Hartley, of Birmingham, voiced the views of those who envisage the joint use of gas and coke. At present, gas is used in some measure by the great majority of householders, primarily for cooking. For space-heating its use is mainly for intermittent needs, and the bulk is supplied by solid fuels, coke yielding the cheapest service. If, however, gas were available on a two-part tariff comparable with that in the telephone service, then a very large increase in the use of gas for space-heating could be expected. For water-heating the present growth of consumption of coke will continue. It is believed that 60 per cent of domestic fuel used in Great Britain is bituminous coal, and the use of much coal is likely to continue for many years. Unless means for burning coal smokelessly can be devised, the only hope for the abatement of domestic smoke will depend on the extension of the production of gas and coke by carbonization. While there will always be some who can and will satisfy all the needs for domestic heat by electricity, Dr. Hartley thinks there will be only a limited development of the 'all electric' house. To-day the coal industry ranks first as the source of domestic heat supplies in Great Britain, but he believes that, given a suitable system of charging, the gas industry would in our lifetime attain the leading position.

The two other papers concerned more technical matters. Mr. T. C. Finlayson, of London, discussed methods for promoting efficiency and, therefore, fuel-saving in the production of gas. Dr. E. A. C. Chamberlain dealt with the same problem as it appears in the use of gas in industry—to-day enormously increased by war conditions. Gaseous fuels in furnaces offer great conveniences and possibility of fuel-saving in furnaces. This very ease of use and effortless control, however, offers a temptation to effortless and unnecessary consumption. His paper dealt with the potential savings by scientific control.

SHOOT ORGANIZATION IN DICOTYLEDON AND MONOCOTYLEDON

A PAPER by C. P. Majumdar (*Ann. Bot.*, 6, No. 21, January, 1942) on the organization of the shoot of *Heracleum Sphondylium* leads to an interesting comparison of the mode of growth of the dicotyledon and the monocotyledon. One distinction frequently made between the two is that the leaf has a comparatively narrow insertion in the dicotyledon, and as a result room is found for two cotyledons around the embryonic apex ; in the monocotyledon the leaf insertion is wide, often completely encircling the axis, and there is only one cotyledon. Two families of Dicotyledons, the Ranunculaceæ and Umbelliferæ, are characterized by unusually wide leaf insertions, and it is suggestive that all the best authenticated cases of monocotylous dicotyledons have been reported from these families.

Majumdar's examination of the development of the vegetative shoot of Heracleum directs particular attention to the effect of this wide leaf insertion upon the development and anatomy of the shoot, and once more to the remarkable 'leaf cushions' and 'bud cushions' which are one characteristic result of this feature of the umbellifer shoot. But more general interest, perhaps, is attached to the interesting analysis of the axial structure in this type, which, in spite of the multi-lacunar leaf-gap, due to the large number of trace strands entering the axis from the one wide leaf insertion, has still the single vascular ring characteristic of the dicotyledon instead of the scattered bundle structure which would be associated with the entry of similar numerous trace strands into a monocotyledon axis. The distinction seems to be linked with the fact that in the dicotyledon the vigorous growth activity associated with the development of the leaf primordium is expressed in increase in the pro-vascular meristem. As a result the main structural features of the leaf, midrib and main veins correspond with the pattern of venation, while superficial ridges on the axis show a similar correlation with the pattern of the vascular ring. In the monocotyledon, on the other hand, both encircling leaf and subtending axis progress in size mainly by increase in the parenchymatous semi-meristem in which the pro-vascular elements are embedded. The latter keep pace with the growth of the tissues around but do not dominate it and so impress the vascular pattern on the general organization. Thus a leaf midrib, if present, may show little correlation with the course of the veins and in the axis the vascular strands lie dispersed among the ground tissue.

The author discusses how these different methods of development affect the interpretation of the shoot of dicotyledon and monocotyledon as an articulate structure, built up of coalescing 'phytons'.

FORTHCOMING EVENTS

Wednesday, July 22

Institute of Chemistry (Birmingham and Midlands Sections) (at the Chamber of Commerce, New Street, Birmingham), at 6 p.m.—Prof. W. N. Haworth, F.R.S.: "Structure and Pattern in Carbohydrates".

Saturday, July 25

Nutrition Society (joint meeting with the Food Group, Society of Chemical Industry) (at British Medical Association House, Tavistock Square, London, W.C.1), at 11 a.m.—Conference on "Dehydration of Foods and the Effect on their Nutritional Value".

Friday and Saturday, July 24-25

British Association (Division for the Social and International Relations of Science) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10 a.m.—Conference on "Mineral Resources and the Atlantic Charter".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned :

Lectureship in Mechanical Engineering—The Principal, Heriot-Watt College, Edinburgh (July 27).

Lecturer (ungraded) in Biochemistry—The Registrar, The University, Liverpool (July 30).

Chief Assistant Engineer—The Clerk and Manager, West Midlands Joint Electricity Authority, Phœnix Buildings, Dudley Road, Wolverhampton (endorsed 'Chief Assistant Engineer') (July 31).

Regius Professor of Engineering at Edinburgh University—The Private Secretary, Scottish House, Fieldon House, 10 Great College Street, London, S.W.1 (September 7).

Mistress to teach Mathematics (mainly Arithmetic and Book-keeping)—The Headmistress, Day Technical School for Girls, Fort Pitt, Chatham.

Master well qualified in Mathematics and Engineering Science—The Principal, Technical Institute and Junior Technical School, Gravesend.

Teacher for Day and Evening Engineering Classes, and a Teacher for Engineering Workshop Practice and Metalwork—The Principal, County Technical College, Gainsborough, Lincs.

Assistant (male or female) to the Public Analyst—The Secretary, Health Department, Grey Friars, Leicester.

REPORTS and other PUBLICATION

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Lister Institute of Preventive Medicine. Report of the Governin Body, 1942. Pp. 24. (London : Lister Institute.) [1

Proceedings of the Royal Society of Edinburgh, Section B (Biology Vol. 61, Part 3, No. 20 : On the Feeding and Breeding of *Calanu finmarchicus* under Laboratory Conditions. By J. E. G. Raymont an Dr. F. Gross. Pp. 267–287. 1*s*. 9*d*. Vol. 61, Part 3, No. 21 : Th Specific Gravity of *Calanus finmarchicus*. By Dr. F. Gross and J. E. G Raymont. Pp. 288–296. 9*d*. (Edinburgh and London : Oliver an Boyd.) [1

Philosophical Transactions of the Royal Society of London. Serie A : Mathematical and Physical Sciences. No. 805, Vol. 239 : Th Geometry of Matrices. By H. W. Turnbull. Pp. 233–267. 5*s*. Serie B : Biological Sciences. No. 579, Vol. 231 : The Lower Devonia Flora of the Senni Beds of Monmouthshire and Breconshire. B W. N. Croft and W. H. Lang. Pp. 131–163+plates 9–11. 8*s*. (London : Cambridge University Press.) [6

Journal of the Institute of Metals. Vol. 67, 1941. Edited b N. B. Vaughan. Pp. xxxii+380+46 plates. (London : Institute c Metals.) 40*s*. net. [6

Metallurgical Abstracts (General and Non-Ferrous). Vol. 8, 194 (New Series). Edited by N. B. Vaughan. Pp. x+434. (London Institute of Metals.) [6

British Rubber Producers' Research Association. Publication No 22 : Analytical Methods in Rubber Chemistry, 5 : Estimation of th Oxygen of Highly Autoxidised Rubber contained in Carboxyl, Ester Carbonyl, Epoxide and Hydroxyl Groups. By F. Hilton. Pp. 319 332. (London : British Rubber Producers' Research Association.) [6

Proceedings of the Royal Irish Academy. Vol. 47, Section A, No 7 : Non-Linear Optics. By Erwin Schrödinger. Pp. 77–117. 2*s* Vol. 48, Section B, No. 2 : The Effect of Temperature on the Vacuola Frequency of *Stylonychia pustulata*. By J. D. Smyth. Pp. 25–41. 1*s* (Dublin : Hodges, Figgis and Co., Ltd. ; London : Williams an Norgate, Ltd.) [7

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Report of the Astronomer Royal to the Board of Visitors of th Royal Observatory, Greenwich, read at the Annual Visitation of th Royal Observatory, 1942 June 6. Pp. 16. (London : Royal Observatory, Greenwich.) [7

Other Countries

Bulletin of the American Museum of Natural History. Vol. 79 Art. 2 : Mammals of Honduras. By George G. Goodwin. Pp. 107–196 (New York : American Museum of Natural History.) [1

Report of the Aeronautical Research Institute, Tôkyô Imperia University. No. 211 : On the Theory of Turbulent Boundary Laye on a Flat Plate. By Tatudirô Sasaki. Pp. 483–492. (Tôkyô : Kôgy Tosho Kabushiki Kaisha.) 35 sen. [1

Imperial College of Tropical Agriculture : Low Temperature Research Station. Memoir No. 18 : Studies in Tropical Fruits, 10 Preliminary Observations on Transpiration during Ripening. By E. R Leonard. Pp. 89–119. (Trinidad : Imperial College of Tropica Agriculture.) [1

Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. 6. By C. G. Abbot, L. B. Aldrich and W. H. Hoover (Publication No. 3650.) Pp. viii+207+7 plates. (Washington, D.C. Smithsonian Institution.) [1

Smithsonian Institution : United States National Museum. Bulleti 178 : Catalog of the Type Specimens of Mammals in the Unite States National Museum, including the Biological Surveys Collection By Arthur J. Poole and Viola S. Schantz. Pp. xiii+705. (Washington D.C. : Government Printing Office.) 1.25 dollars. [3

National Research Council of Canada. N.R.C. No. 1061 : Illumination and Visual Range under Water. By R. Ruedy. Pp. 32. (Ottawa National Research Council of Canada.) 25 cents. [3

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College of

UNIVERSITIES IN WAR-TIME

THE extent to which the universities of Great Britain are addressing themselves to the war effort is well indicated in an admirable series of articles which has appeared in *Britain To-day*, and also by a survey of the "University of London in War-Time, September 1939–March 1942", recently circulated in the Convocation of the University. Their part in reconstruction is no less vital. Both aspects of university war-time activity are reflected in two articles, which have appeared in a recent issue of *Science* (95, 369–72, 372–73 ; 1942), by Dr. Arthur Cutts Willard and Prof. A. J. Carlson respectively. Dr. Willard's address, "The University and the War", given at the Washington award dinner of the Western Society of Engineers, describes the ways in which the courses of the University of Illinois have been modified to meet professional demands for various services and its contribution to the war programme of the United States through the research activities of its scientific staff. The mere list of activities cited by Dr. Willard indicates that the University of Illinois is addressing itself to the immediate practical tasks of education, training and research, with vision and understanding. The contribution to morale of the Extension of Service in Agriculture and Home Economics, the trained specialists of which present to the people the results of scientific research carried out by the Agricultural Experiment Station, often in co-operation with the U.S. Department of Agriculture, is noteworthy, and the Engineering Science and Management Defense Training Programme is most impressive. Adult education, education in the armed forces and the encouragement of reading on the understanding of America, its aims, the War and the peace to follow are all represented.

Whereas the material contribution of the universities, of which London and Illinois are only examples, is important, the moral and spiritual contributions are even more important, and it is to this particularly that Prof. A. J. Carlson, of the University of Chicago, directs attention in his paper "The University and the Present Crisis". Emphasizing the particular dangers inherent to a university in time of war—which are involved in the very antithesis of education and war—he warns us of the importance of a re-examination of the relation of education and democracy before we attempt to modify educational institutions or systems in a period of hysteria and fear. There should be no relaxation in our standards of education, university or other. A period of war is not the best time for inaugurating basic educational reconstruction, though it is well to give timely consideration to the subject ; and a democracy should be specially on its guard against the dangers to education and to fundamental research which are always present in a war effort of the magnitude of that at present required.

From these comparatively negative obligations, Prof. Carlson turns to the positive obligations of the university at the present time. Among these he places foremost a tightening of the intellectual belt, a greater attention to duty for teachers and students. Waste of time must be rigorously eliminated, and both teachers and taught must recognize their responsibility for seeing that the golden hours are used to the full. The practical duties of placing university facilities at the disposal of the Government for training men in the special services of the armed forces, and for aiding in the solution of scientific and other problems forced on us by the War are put first, the training of the full quota required each year of medical men, physicists, chemists and engineers comes next, while finally Prof. Carlson stresses the importance of free minds, informed by principles derived from human experience through the ages, and open, no matter what waves of change beat upon them.

The duty and responsibility for aiding in the development and maturing of such creative and open minds lie mainly on the university, both in peace or in war. The universities are among the ultimate safeguards of freedom of thought, and to them we must look for the constructive criticism and imaginative insight essential in the elaboration of any sure plans for reconstruction when victory is won. The intellectual activities of the university, as President Hutchins writes, are the symbol of everything we have to defend, and the best service the university can render in the defence of the United Nations is to see to it that these activities are maintained in full force and vigour. Only the universities can carry the incredibly heavy burden of formulating, clarifying and vitalizing the ideas which should animate mankind; they must carry that burden, even in total war, if civilization is to be saved.

It is encouraging that the exceptional stimulus that the present struggle is undoubtedly giving to scientific thought is not leading the universities to overlook the great resurgence of social, economic, political, industrial and educational leadership which is required nationally and regionally. Possibly our Russian allies are prone to over-emphasize the material side of the university's contribution, as an article by Dr. P. Kapitza "Science and War" in *Science* (95, 396; 1942) suggests; but Dr. Kapitza also points out that the strain and tension due to war are exposing the weak spots in our economy, technique and organization, showing the points where the State must first be assisted, and clearly formulating the demands which society makes on science. In his speech in the House of Commons on June 16 on the estimates for his Department, Mr. Butler, president of the Board of Education, referred to the contribution to the war effort in the steady flow of qualified recruits for the specialized services, but it was clear that the importance of something more than academic qualifications for leadership was in his mind.

This was shown, for example, in the appointment of a committee, with Dr. McNair, vice-chancellor of the University of Liverpool as chairman, to investigate the recruitment of teachers from other academic services, as well as the question of the supply of teachers and of youth leaders. This and other steps already taken, such as the short courses for teachers in the history and current affairs of the United States and of the U.S.S.R., initiated in close co-operation with the American and Russian Ambassadors, and the establishment of a body under the chairmanship of Lord Fleming to work out a plan under which the facilities of a boarding-school education may be extended to those who desire to profit by them, irrespective of their means, while but indirectly connected with the universities, will facilitate the fulfilment of their task of supplying the nation with the trained leaders it requires.

The quality of the leaders which a university provides does not indeed depend solely upon the university itself. It depends partly at least upon the quality of the students entering on its courses, and therefore to some extent on educational systems of the schools. It is well to find, therefore, a new outlook on education reflected in the House of Commons debate, and such promising plans outlined in Mr. Butler's speech, though it should be remembered that much of the information required as a basis for decision has already been set before the Government by the Consultative Committee of the Board of Education with the aid of school inspectors. What is, in fact, required of the Government here is a definite plan for education, from the primary school to the university, upon which ultimate decision and action can be taken.

The real problem in a democratic society, in education as elsewhere, is to secure the full use of the nation's talents. The McNair Committee may be expected to advance proposals regarding the supply of teachers which will redress the lack of missionary zeal and first-rate competence; but this is only one direction in which the task is to open the door to men and women who can best serve by their boldness and ability, to give them opportunity in their public work and in their private lives to execute plans of action and to take responsibility. In the Civil Service adventurous spirits are lacking; in industry, vision and courage; in politics, honest, able men are scarce; and pride, enthusiasm and capacity are too often absent from the humblest to the highest spheres of work.

It is the function of the nation's schools and universities to provide the channels along which these men and women will pass. To make the schools themselves open to all equally, and at once uniformly well endowed in equipment and personnel and widely diverse in their freedom to develop, are essential steps to this end. Also it is essential that, simultaneously through the universities and by adult education, the nation should be brought to a new appreciation of the moral values upon which democracy is built and without which we look in vain for real leadership of youth or of any age.

If the schools and universities are to supply this creative leadership which is our first need, both alike must concern themselves with the preservation of moral standards and spiritual values. Too long have we allowed, as Lord Elton points out in his stimulating book "Saint George or the Dragon", the military virtues of loyalty, courage, endurance and discipline, upon which our very existence now depends, to be despised, ignoring the fact that they are the very basis of civilization itself; and punctuality, regularity and industry to be sneered at as slave values. Yet without these last even creative genius will never see the fruition of its gifts to man; and the first, though not the only Christian virtues, lie so close to the core of Christianity that we can scarcely wonder that twenty years campaign against them has led to a weakening in the hold of Christianity itself. Indeed, they can be reduced, as Lord Elton notes, to a single quality, unselfishness, and if there is one defect more than any other responsible for our unpreparedness for the present War, for the defects of the present social order, for the softness and love of ease and pleasure which may have led our foes to misjudge us but also earned their just scorn, it is the directly opposed vice of selfishness.

We may well be grateful to Lord Elton for his penetrating exposure of the shallow and misguided intellectualism which for twenty years has been so rampant against the virtues we need alike to win the War and to build the peace. Unless that lesson is learnt aright, there will indeed be no place to build. Civilization is self-discipline, and its advance is measured by man's gradual mastery of his more savage instincts. That much at least Nazism has revealed to us, and having once overthrown that menace it would be folly indeed to throw aside the moral values which have brought us to victory without making sure that we have found new and enduring values adequate to the spiritual as well as material tasks which lie ahead.

The extent to which the moral and intellectual foundations of civilization have been shaken is nowhere better revealed than in our lost capacity for moral indignation. The evil could, however, scarcely have gone so far had there not been a widespread indifference to the basic importance of character. From this the War has happily aroused us, and it has already been demonstrated that the nation possesses formidable reserves of courage, loyalty, fortitude and endurance, and that there is little lack of those willing to accept responsibility. It must, however, be the first concern of any kind of educational system to see that the emphasis on the training of character is never again omitted, from the university downwards. There must be no further betrayal, and the extent to which the conception of service is replacing that of private profit in the realm of industry and commerce must be reflected throughout that of education. That idea lies at the heart of the youth movement, but unless it is fortified continually by the teaching and example of the schools, the movement will never fulfil its promise.

In his stimulating chapter "Not Examinees, but Men", Lord Elton is writing primarily with the schools in mind, but what he says of them with regard to training in citizenship and the more effective choice of leaders is equally true of the university. The system of examination in book learning alone can no longer be retained. Means must be found of testing other qualifications for leadership besides the capacity to absorb and reproduce knowledge. Courage, common sense, originality of mind and sound physique—these also must be taken into account; and we should make sure that the educational ladder of the future is one to be climbed by boys who show signs of initiative and character as well as intelligence.

In the gearing of intelligence to character and experience, the retention of national service after the War may well play an important part. Conscription, whether in the fighting services or in the factories or on the land, might do much to toughen the physique, socialize the instincts and enrich the later learning in school or university. Moreover, by emphasizing the idea of obligations and services to the State from every citizen as the condition upon which its protection and privileges are enjoyed, it might do much to fortify the youth of the nation against the softness and heresies which the propaganda attacked by Lord Elton broadcast so disastrously between the wars.

The universities have a part to play here through the recognition of social studies. By a fuller and deeper appreciation of the importance of man as a vital entity in the structure of a dynamic civilization, they can lay the foundation for, or round off, as the case may be, the experience which a short period of national service can give.

No excellence in the material contribution of the universities in peace or in war can atone for any shortcomings in moral or spiritual leadership. It is not enough to recognize the shallowness and ineffectiveness of much of the intellectualism and scepticism of the last twenty-five years. Without idealism, without conviction, without a sense of the positive values of life, and a vision of those enduring spiritual verities of mankind, now imperilled, but by which alone man has made his slow advance out of the darkness and chaos of barbarism, there can be neither the moral passion which will overthrow the aggressor nor the balanced view of life which will enable a nobler and wiser civilization to emerge from the present turmoil. Man needs the inspiration of a living faith and an adequate working philosophy if he is to bring to the tasks that now confront us the serenity and the conviction that will bring them to success, and overthrow the forces making for social disintegration, whether in society, in industry or in international affairs.

The late Prof. J. L. Stocks said truly in his essay on the need for a social philosophy that our generation is not being given the tools necessary for a sound critical judgment in social affairs. Philosophy, he says, alone has the power to give them those tools. When men do not know the faith by which they live, they will be apt inadvertently to betray it. The universities are no longer academies of religion, though for centuries it was one of their main tasks to train the leaders of the Church. To them men may fairly look, not for the light of truth alone but also for the compelling force of moral conviction, for the enthusiasm which has a place in all genius and all creative work, and for the vision and wisdom by which men may steady their course and walk surely in this anxious, crumbling world.

The universities fail of their full purpose unless they give to their alumni in some measure the power to see life steadily and to see it whole, and the capacity to re-discover and re-create for each fresh generation truth in all its many facets which, as Dr. R. R. Marett reminds us, can never afford to stand still. With courage, loyalty, discipline and endurance, a civilization may be strong to defend itself, but without also culture and religion it is unworthy and indeed unable to survive.

Here then is the point at which the universities must face anew the interpretation of religious experience and of the spiritual heritage of mankind. Their responsibility to-day for imparting to all their students and scholars some sense of the scientific outlook and spirit, with its untiring passion for truth, the ceaseless testing and sifting of the accumulated knowledge of mankind as part of the discipline which equips men and women alike for life and leadership in this modern world, is admitted. There must now be recognized also their responsibility for instilling as a counterpart to legitimate scientific scepticism a respect for the accumulated wisdom of mankind, and a training in cultural and ethical values which will lead to the formation of sound judgment.

To leave the young, in the sphere of wisdom, to re-discover painfully for themselves the moral and spiritual truths which the accumulated experience of past generations has accepted as making for the good life in the individual and in the State is neither science nor sense. In the sphere of knowledge, the scientific worker does not hesitate in practice to accept the conclusions of the past, or to stand upon the shoulders of his predecessors. Both in knowledge and in the realm of wisdom, to reject all the observations and experience of the past and to insist on verifying afresh every single fact or technique leads at once to chaos and deadlock, not to progress.

It is this task of cherishing the rich moral and spiritual heritage of mankind and stimulating the creative thought which will lead to the discovery and formulation afresh of a faith and a philosophy adequate to meet the challenge of to-day that is the supreme responsibility of the universities. They, as none other, can build up the aristocracy of ability and integrity which Zinsser insisted is essential to maintain a democracy and protect it from deterioration and eventual chaos. If science and religion are to found a fellowship which will lead men forward, facing change in the spirit of science, trending upward in the way which religion alone in the elements of human experience, as Whitehead points out, has consistently done, the universities will assuredly prove a decisive factor. Only as they play their full part can those bright hopes of the youth movement or the vision of service, of sacrifice and adventure dawning anew on the minds of men and women in so many scattered walks of life, find their fulfilment in action and in a fellowship strong and serene enough never to be turned again by selfishness or love of ease from the task of building a nobler world order and adding, in response to the call of prophetic statesmanship, their own contribution to their heritage of culture, learning and religious experience.

THE ANATOMY OF FREEDOM

Freedom: its Meaning

By Benedetto Croce, Charles A. Beard, Jacques Maritain, Bertrand Russell, Gaetano Salvemini, Vilhjalmur Stefansson, Henry A. Wallace, Henri Bergson, Alfred North Whitehead, Thomas Mann, Felix Bernstein, Harold J. Laski, John Macmurray, Albert Einstein, J. B. S. Haldane, Lancelot Hogben, Frank Kingdon, Franz Boas, John Dewey. Planned and edited by Ruth Nanda Anshen. Pp. vii+335. (London: George Allen and Unwin, Ltd., 1942.) 16*s*. net.

A VARIED assortment of essays make up this book. Though it is certainly useful to have these different points of view and different subjects brought together for comparison, the method has disadvantages. The essays are arranged in alphabetical order of the authors' names, an arrangement more convenient for the editor than the reader. Three of the essays (those by Bergson and Profs. J. Dewey and A. N. Whitehead) are chapters taken from published books, and it is possible that their original context suited them better. There is a serious gap in the ground covered: namely, no more than incidental references to the legal aspect of freedom. Prof. H. J. Laski could have done this very well, but he has preferred to discuss the problem of nationalism as an obstacle to freedom. If only each writer, before finally committing himself, could have read a preliminary draft of the other contributions, it would have been an improvement. For example, it would have saved Dr. V. Stefansson 'flogging a dead horse' if he had read the explanation by his fellow anthropologist, Prof. Boas, that primitive man lacks the concept of freedom. Unfortunately, this last suggestion is a counsel of perfection. Only a superhuman editor could cope with such conditions.

Despite these defects, the editor's claim to have reached a synthesis is more nearly realized than one would have thought possible before reading the book. Present-day facts speak too clearly to be ignored. We can all see, to quote Benedetto Croce, "the barrenness in terms of thought, science, art, civic virtues, human relations, that systems based on violence—or on what amounts to the same thing, on authority—commonly show. Everything sound and productive that still survives, or flourishes in them in the directions mentioned, survives and flourishes either through the survival of free minds or through the persistence of acquired habits. But these latter gradually weaken for lack of sustenance and replenishment and through the passing of the human beings who possess them. Meanwhile none of the new formulas or ideals is allowed to defend itself in orderly discussion, to justify itself by critically tested arguments, by interpretations of history, in a word by perspicacious, cautious, sober research. It is forced to drone its arid mechanical assertions over and over again, without variations, without proofs, without elaborations, deriving such animation as it can from an accompaniment of threats" (p. 57). The intellectual equipment we need as defenders of freedom is to understand the nature of social and political freedom, the historical circumstances that have favoured its development, how much we have of it now, and what is necessary for its preservation and extension. These are the topics discussed in this book.

There is a widespread and dangerous belief that the obstacles to freedom are incidental difficulties asily put right by some simple change in State rganization. As Prof. J. Macmurray provides a uch-needed corrective, his essay is worth condering specially, even if it means neglecting other xcellent contributions. Freedom, he says, "as we xperience it resides in the adequacy to our purposes our powers, opportunities and means" (p. 178). onstraint, its opposite, is of various kinds but the nly one of importance is that imposed by the clash human wills. When something that is otherwise ossible is rendered unattainable by the opposition f another person, it is felt and resented as oppression. hile increase of scientific knowledge has rendered any things possible which in the past were objecvely impossible, human relations have been such at many possibilities have not been realized. Thus crease in power has meant actual diminution of eedom. The main source of trouble is that human lations are of two sorts, depending on the kind of otives involved. If two men are partners in business, e important fact about the partnership is its rpose. If the purpose is accomplished or found to unattainable, there is no reason for that partnerip to continue, as it is only a means to an external d. The success of the partnership depends only ghtly upon any personal affection or animosity the rtners feel for one another. Indeed it is not necesry for them to meet or know each other or comunicate except on business. This kind of relationip is the sphere of economics and politics, and gives e to 'society'. But if two men are friends the lationship is quite different. Though they may ve a common purpose and be partners in business, is pointless to ask what is the purpose of the iendship. This is the kind of relationship that gives e to 'community'.

"In the nexus of personal relationship community capable of generating and containing society within elf, of making co-operation for the achievement of mmon ends a means to itself and an expression of elf. Therefore it is clear that if the problem of mmunity is solved the problem of society will be ll on the way to solution" (p. 188). Society, on e other hand, can exist quite independent of comunity. It is also more permanent and powerful. As rsonal affections and animosities hamper rather an promote social organization, society is apt to mand from its members loyalty to common ends erruling private ends. It also tends to treat its mbers as means only. Struggles for freedom have en mainly attempts to change the organization of iety, with disappointing results for the most part. of. Macmurray concludes pessimistically that there no technique of freedom. In other words, liberty d equality are empty forms without fraternity, and ere are no rules for achieving this.

There is no doubt Prof. Macmurray is right in ying that by itself society can generate tyranny t not freedom. Still, it is possible that his pessimism s too far. He may be looking too exclusively at debit side of society and the credit side of commity. Granted that love and affection are the basis community, it was these that produced the blood d. There has been no greater single human ievement than that by which an act of violence, ich was once a private wrong to be avenged on family of the agent by the family of the sufferer, become a breach of the King's peace. This is the ans by which we are free to walk abroad unarmed, leave our doors unlocked and to sleep in our beds hout fear (except for acts of the King's enemies). Society has stepped in to prevent community destroying itself. An even greater attempt, never completely realized, is the Roman notion of the equality of all before the law, in place of one rule for ourselves and our friends and another for outsiders. Law is the only final safeguard of freedom, but it does not work automatically; it needs active support and criticism, such as society cannot produce. Prof. Salvemini rightly emphasizes the democratic virtue of humility, because humility is needed for tolerance. But this is one thing the democrat cannot tolerate, so that he needs the contrasted virtue of vigilant sympathy that will not stand by and see injustice done.

A. D. Ritchie.

THE LABORATORY MOUSE

Biology of the Laboratory Mouse

By the Staff of the Roscoe B. Jackson Memorial Laboratory. Edited by George D. Snell. With a chapter on Infectious Diseases of Mice, by J. H. Dingle. Pp. ix+497. (Philadelphia: The Blakiston Company, 1941.) 7 dollars.

The Roscoe B. Jackson Memorial Laboratory in Bar Harbor, Maine, celebrated its tenth anniversary in 1939. During this short space of time, the staff of the laboratory, under the leadership of Dr. C. C. Little, in addition to numerous important investigations, has carried out a task which puts large sections of medical research deeply in their debt. The primary object of the laboratory is cancer research; Dr. Little and his team realized very early that many phases of this problem cannot be tackled successfully without bringing the genetic variables under control. A homogeneous strain of animals can be produced by continued close inbreeding. But a single pure line would be of very limited value; so the laboratory set out to establish a large number of inbred strains of mice differing widely both in the incidence of tumours and in the type of malignancy to which they are prone. But this 'variety of uniformity', unique in mammals, is also an almost untapped source of material for the study of innate and environmental factors in nearly any conceivable phase of mammalian biology and pathology. It would be difficult to muster a more competent team to write a biology of the mouse than the staff of the Jackson Laboratory.

The book under review brings together most of the scattered information on the mouse as a laboratory animal and contains more than 1,100 references. But it is more than a compilation. Some of the sections are based on research specially undertaken to fill in gaps in our knowledge, and unpublished data on many subjects are scattered throughout the work. The book opens with a clear and well-illustrated section on early embryology (54 pp.) by G. D. Snell, followed by a chapter on reproduction (33 pp.) by the same author. Histology (79 pp.) is treated by E. Fekete with numerous excellent photomicrographs. Beautifully illustrated is also the section on spontaneous neoplasms (66 pp.) by A. M. Cloudman, which is followed by a short account (14 pp.) on gene and chromosome mutations by G. D. Snell. Dr. C. C. Little contributes chapters on the genetics of spontaneous tumour formation (31 pp.) and of tumour transplantation (31 pp.) respectively; neither of these sections is exhaustive, but it was probably a wise decision to abstain from monographic treatment of a subject so much in flux. Short sections on endocrines and tumour formation (11 pp., G. W. Woolley) and the "milk-influence" in tumour formation by its discoverer, J. J. Bittner (4 pp.), are followed by a useful discussion on the value of inbred and hybrid animals in research (W. L. Russell, 24 pp.), which is addressed to the non-geneticist and should go far to clear up common misunderstandings. Parasites are treated by W. E. Heston (31 pp.) and infectious diseases very extensively (95 pp.) by J. H. Dingle, of the Harvard Medical School. A short section on care and breeding (J. J. Bittner, 5 pp.) and an adequate index conclude the book.

The contributions are generally well written and excellently illustrated. It will be indispensable to all workers who use the mouse as an experimental animal, and to students of cancer in particular. I have noticed only two slight errors. The root of the upper incisor does not reach so far back as the molar region (p. 110), and the gene for hypotrichosis juvenilis does not overlap normal (p. 241). HANS GRÜNEBERG.

NEW CYTOLOGICAL TECHNIQUE

The Handling of Chromosomes

By C. D. Darlington and L. F. La Cour. Pp. 166+16 plates. (London: George Allen and Unwin, Ltd., 1942.) 8*s*. 6*d*. net.

THE study of chromosomes is a branch of biology which has expanded very considerably in the last fifty years and has recently acquired an extended popularity owing partly to its association with genetics and partly to an increased technical facility which has been gradually built up from the accumulated experience of many workers. The modern microscope, perfected at the end of the last century, and the use of the microtome were understood before the War of 1914–18 and have not been improved appreciably since. On the other hand the last twenty-five years have added the smear techniques associated with the use of rapid and transparent (but often transient) stains, which can also be applied to extend the use of the microtome to very thick sections. Some improvements have been made in the formulæ of fixatives and, for certain purposes, by using reagents such as acetocarmine and rapid macerating treatments involving hydrolysis with hydrochloric acid, it is now possible to see in a few minutes things which a generation ago would have necessitated a delay of several days. In other cases whole fields of new observation have been opened up by the development of special methods such as those now available for the demonstration of spiral structure. The most recent innovation, and one which is certain to be further extended in the future, is the application of specific chemical reactions such as selective digestibility and microchemical colour tests such as Feulgen's reaction to the study of chromosome structure.

In an expanding science, some guide to new technical advances is needed from time to time and the part which Darlington and La Cour's little book could fill is obvious. Whether it in fact does so is less certain. Much useful information is undoubtedly contained regarding new methods, some of which are indeed published here for the first time. For this the cytological specialist will be grateful though he may perhaps resent some sweeping generalizations and a tendency to over-simplify, for example, the labelling of Caspersson and Hillary's lanthanum acetate trypsin method as "precipitation and digestio of nucleic acid" (p. 57), when the essence of it precipitation of nucleic acid and digestion of protei

The book is, however, not primarily addresse to cytologists but to "teachers and students in scho and university". Presumably for their benefit spa has been given to elementary instructions on how write a paper (Chap. 12) and to drawings of comm utensils such as slides and staining jars (pp. 126–7 The uninformed reader would, however, go away wi the impression that all cytology is very new ar very easy and that he need know little or nothi about information available before about 1920. Th appears to the present reviewer to be a great mistak The modern developments amplify, but do not any means eliminate, the usefulness of the old achievements. Sound microscopy is still the keyno of successful cytology and a student can profit ve greatly by learning to use old equipment such as t paraffin oil microscope lamp, and by careful perus of an old and classic handbook on the microsco such as that of W. H. Carpenter (eighth edition, 190 still available in most reference libraries). It doubtful whether he could acquire even the minimu of necessary information on the use of the microsco for high powers from the very brief and somewh peculiar paragraphs devoted to it in the book und review; though he might easily be confused references to the numerical apertures of lenses a condensers, made without explanation of the ter and to discussion of the relative merits of differe resolving powers when these are expressed mere as microns (p. 24).

It is difficult to see what class of reader cou benefit by perusal of the chapter on photograph and the price of the book has certainly been enhanc by the inclusion of large photographic illustratio using magnifications up to ×10,000 although it physically impossible, with visual light, to obta any image of detail finer than will reproduce in ha tone at a magnification of ×3,000, and for scienti (as opposed to artistic) purposes even this degree enlargement is generally excessive. The difficul of using an old (and valuable) stain such as hæm toxylin is stressed but it is trivial in comparison wi that of applying polarized light to chromosom problems, yet a student would receive exactly t contrary impression from the descriptions given the property investigated by the latter method incidentally, not "rotation of polarized light" (p. but birefringence, that is, the property which a chrom some may or may not possess of splitting a beam polarized light into two beams polarized at right ang

It is not difficult and it is sometimes desirable cut sections thinner than $14\,\mu$, but a student's troub would be magnified by making him use only extremely hard wax of m.p. 58° C. for such a purp (p. 48), for, in temperate climates, almost all cy logical material, in plants at any rate, will cut sa factorily in m.p. 52–54° C. at thicknesses of 6–1 and extra hardness is only needed for exceptio specimens or for thicknesses of $4\,\mu$ or less.

To meet adequately the requirements of a stud or inexperienced teacher, much greater care wo need to be expended on the accuracy and bala of the matter to be presented. For a more experien reader, on the other hand, much will be redund and emendation of details will be necessary, bu solid core of real value remains if the book is trea as a source of introductory reference to some teresting, new and useful laboratory methods.

e more precise, it is worth buying for the sake of me of the notes contained in the appendixes and r some of the information summarized in the apters dealing with the making of smears and uashes, with the handling of special tissues such as ollen tubes, embryo sacs and salivary glands, and ith the application of special agents such as X-rays, rugs and the various treatments for spiral structure.

I. MANTON.

PRECOLOMBIAN HAITI

xcavations in the Ft. Liberté Region, Haiti

y Froelich G. Rainey

ulture of the Ft. Liberté Region, Haiti

y Irving Rouse

Yale University Publications in Anthropology, Nos. 3 and 24.) Pp. 48+196+35 plates. (New Haven, onn.: Yale University Press; London: Oxford niversity Press, 1941.) 21*s*. 6*d*. net.

THESE two papers, issued as a single volume, give an account of the culture of a small area n the north-east corner of the Republic of Haiti, nd of the excavations on which it is based. With ne exception, the sites lie within an area measuring bout 7 km. by 5 km., and the remaining site is bout 10 km. farther east.

The first paper is an admirably concise account of he excavations by Dr. F. G. Rainey. Eleven sites ere investigated, all of them shell middens. Five f these yielded a culture characterized by flint nplements without pottery, burials or defined earths; the remainder, which were somewhat rger and thicker, though the maximum thickness f deposit was only about 1·5 metres, contained ottery. Of these, four were assigned on the basis of eir pottery type to one culture, called the Meillac, nd the other two to another, with a different type f pottery, called the Carrier. A few primary burials ere found in the middens on Meillac sites: they ere in poor condition, but appear to have been in flexed position, and in two cases were accompanied y pots. No other grave goods were found. There as also evidence of secondary burial. There was o stratification which threw light on the relative ges of the cultures on any of the sites, but a small dmixture of Carrier pottery was found on three of he Meillac sites.

The paper is illustrated by two maps, both of hich have been reduced too much, a criticism which pplies particularly to that of the Ft. Liberté Region, hich also lacks a scale. The remaining figures are lans and sections of the sites. These are perfectly lear, but the vertical scale has been exaggerated as uch as ten times in several cases and forty in one. Where possible, it is better to draw sections true to ale: the amounts of exaggeration cited are in any vent excessive.

The second, much longer, paper, by Dr. I. Rouse, an account of the cultures. He classifies them into ur periods. The first, comprising Rainey's flint tes, is occupied by the Couri Culture. Period 2 is blank separating the Couri from the Meillac Culture, nd no evidence for its existence is presented. Preumably it is based on the absence of any admixture Meillac objects on Couri sites, but this is not an dication of any value when the small size of the ea studied is considered. Period 3, with its four tes of the Meillac Culture, is divided into four subivisions. The evidence for this appears to have been presented in a previous paper by the same author, but the value of these minor periods is on the face of it extremely dubious. Period 4 comprises the two sites of the Carrier Culture.

There is no reason to doubt that the Couri Culture is the earliest, but the question of the relative ages of the other two is more difficult and may not yet be finally settled. The author says that he demonstrated the greater age of the Meillac Group in his previous paper "by distributional and statistical methods", but their merits cannot be judged since the paper is not available. He believes that the Carrier type of pottery originated in the Dominican Republic when the Meillac type existed in the Ft. Liberté region, and that the Carrier type, which is the more sophisticated, replaced the other by diffusion. It seems likely that this explanation is correct.

Dr. Rouse's account of these cultures could scarcely be fuller, but it is difficult to read and excessively long owing to his method of presentation. He is trying to introduce a definite procedure for classifying culture and in doing so he uses a lot of terms which are not likely to command wide acceptance. In his desire to apply his system throughout the work he involves himself in much unnecessary repetition and many glimpses of the obvious. The term 'mode' lends itself particularly to this sort of thing. Absurd 'modes' are legion, but one list must suffice as an example. After a detailed description of the petaloid stone celts (in the course of which we are told that they are relatively heavy, rigid and hard !), we find the following conclusions on p. 95: "The following are the modes for petaloid stone celts: igneous rock, metamorphic rock, dullness of the rock, bright greenness of the rock, flaking (?), battering (?), grinding, polishing, resharpening, high surface polish, petaloid shape, pointed butt, convex sides, convex edges, semicircular bit, large size, small size, use for chopping, and ceremonial use. . . ." The conceptions of "alternative" and "optional" modes do not seem to clarify the descriptions, and it is difficult to see what purpose is served by the numerous tables giving "alternative and optional relationships of the modes", etc., particularly when they contain column headings like the following: "No overall shape", "No body", "No aperture", in a table dealing with open bowls. They appear to represent an abortive attempt to reduce classification to a mathematical basis, and they would have been better omitted.

Appendix I consists of a detailed report by specialists on a technological analysis of Meillac and Carrier sherds, in the course of which they state definitely that there is no evidence of artificial tempering. In spite of this, the author discusses the whole question afresh on p. 55 and suggests the same conclusion as "mere conjecture".

The plates consist of excellent photographs of the objects, of which there are plenty of examples. There are, however, several numerical mistakes in the references to them in the text.

The final chapter is an attempt to relate the cultures to others in the West Indies. It contains thirteen pages, of which more than seven are occupied by tables, most of which do not add any useful information to the work. The result of it all is to show that the Meillac and Carrier Cultures have been proved to exist elsewhere in Haiti, but that it is premature to try to correlate them with anything farther afield, a fact which is clearly demonstrated by the high proportion of space occupied by queries in the final table.

G. H. S. BUSHNELL

THE VALUES OF SCIENCE TO HUMANITY*

By PROF. A. G. TANSLEY, F.R.S.

TO most people to-day the word science suggests, first of all, the marvellous modern applications of science to human use. Such inventions, yearly increasing in numbers and in scope, have enriched human life not only on its material side, but also indirectly, in æsthetic, intellectual and spiritual aspects. By quickening every sort of intercommunication they have put the most widely separated products of human thought and creativeness at the disposal of everyone. By 'annihilating time and space', as the vivid phrase goes, they have drawn the peoples of the world together.

It is tragically true, of course, that scientific inventions have also placed enormous means at the disposal of those men of evil will who have seized power in their own countries and have taken advantage of the deficiencies of international organization to disrupt and overwhelm neighbouring States. Shallow and thoughtless critics have blamed science and men of science for these catastrophes. They should rather have blamed man's failure to develop an adequate ethical standard in international relations, his failure to acquire that sense of human solidarity with which the race can no longer dispense if it is to survive under tolerable conditions. Not science but lack of morality is the culprit. Man's material power has altogether outrun his ethical development. It is as impossible to check scientific discovery and its application to human purposes as to stop an inflowing tide. What those purposes shall be must depend on the degree of man's spiritual development, on the values in which he really believes.

The primary motive that prompts a man to learn and practise science is the desire to obtain organized knowledge of the objective world around him. Such knowledge may be sought for its own sake or for its practical usefulness. When the former motive is predominant we have been accustomed to speak of 'pure science', as contrasted with 'applied science' when scientific knowledge and scientific method are used for the solution of practical problems of human life. The devising, improvement and elaboration of technical methods of dealing with materials and processes for practical ends may best be called 'technology'. But we are told by an increasingly vocal school of scientists turned publicists that there is no real distinction between pure science and technology, that the root of man's interest in knowledge of the natural world is the use he can make of it, and that pure science is either the theoretical formulation of knowledge originally sought for purely practical ends or, when it is not this, a form of recreation which is at best harmless if it does not divert attention from more serious and useful pursuits.

The essence of science is said to be the acquirement of power over Nature. Science has been actually defined as "the system of behaviour by which man acquires mastery of his environment". We had supposed, until we were thus instructed, that science meant a kind of knowledge, not a kind of behaviour. Indeed the most elementary thinking about the human mind and human activity would seem to require a primary distinction between knowing an behaving.

But if we pass over this extraordinary misuse o ordinary language we are confronted with two contradictory views of the status and function of scienc —on one side the view that science is a body c knowledge primarily concerned with the effort t satisfy human needs, 'pure' science, so far as it ma be entitled to recognition at all, being an offshoot so to speak, of this body of knowledge; and, on th other hand, the view that pure science is a primar body of knowledge and theory, which has no necessary relation to practical needs, but much of whic may be applied to those needs with far-reachin effects. What is the explanation of this contradiction I think it may be found in the confusion of historica and psychological points of view. Historically, pur science may fairly be said to 'emerge from' a bod of knowledge much of which is empirical and technological. Psychologically, pure science, as it exist to-day, has a completely independent status, an incidentally is the source of all significant technological advance. Let us consider this matter in som little detail.

That the kind of knowledge we call science lead directly to increased power over Nature, that it i the source of our wide and powerful modern contro over the materials and forces of the external world is obvious to all. Primitive man got the first glimmerings of the foundation of scientific knowledge—that similar causes produce similar effects—in th conditions of his hard daily struggle to maintai himself and perpetuate his race in a hostile or a best an indifferent world. Such knowledge was purel empirical knowledge. Fire burns, but it will als cook food and scare off wild beasts; water drowns but it also quenches thirst; sharp flints can be use as weapons and also as tools, and so on. Empirica knowledge is not science though it is the indispensabl basis of science. A good many writers are in th habit of using the words 'science' and 'scientific' fo *all* knowledge gained by primitive man, and in th earlier civilizations, about his material environment simply because it related to the objects and processe which now form the subject-matter of branches o science such as physics, chemistry, geology an biology. Most of this knowledge was purely empirica Science does not come into existence until some kin of generalization is formed in the mind, a generalization that can prove its validity when it is applied t new phenomena.

The transition from purely empirical knowledge t the first rudiments of scientific knowledge was n doubt an imperceptible transition. We do not kno and can never know the times and places and way in which the first ideas which can properly be calle scientific arose out of the bodies of empirical knowledge. We shall be safe in giving the first place t the general notion of causation, an essentially abstrac conception which underlies all the rest. The causa nexus between happenings could not fail to impres itself on the primitive human being experiencing th events of his daily life. That *B* happened *because* had happened must have been a very early thought

There is no evidence and no likelihood that th basic mental equipment of primitive man—at leas of men of our own species from Upper Palæolithi times—was substantially different from our own but he was without our *heritage* of knowledge. H had to begin from the beginning, from the platform of adaptive instincts built up by and inherited fro his sub-human ancestors. But he had in supreme degree the power of adaptation and intelligent modification of those instincts to new conditions of life, and with the acquirement of the power of articulate speech he could initiate an oral tradition of knowledge. Thus bodies of traditional knowledge were established, handed on, and gradually increased from generation to generation, varying according to the different environments in which different human groups found themselves. These bodies of empirical knowledge necessarily related primarily to the vital needs of the group, and so it has been throughout the hundreds of millennia of man's history. Equally in pre-glacial times, when man first began to emerge from among his ape-like ancestors and in our twentieth century of the Christian era, equally in London and in Timbuktu, the individual *must* acquire the knowledge immediately necessary to his continued existence, however widely different the content of that knowledge may be.

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* Extracts from the Herbert Spencer Lecture delivered in the University of Oxford on June 2, 1942. The complete lecture is published by George Allen and Unwin, Ltd., 1*s*. 6*d*. net.

So it is also with the aggregate knowledge of a particular human group or community. Those communities which had acquired the particular type and degree of knowledge and skill best adapted to their particular environment were the most likely to survive; and when they came into competition or open conflict with others, those communities would win whose knowledge, skill and material equipment best fitted them for success in the struggle, because the environment of each community included the incidence of its competitors.

How far did primitive man seek objective knowledge of Nature for its own sake, besides acquiring the knowledge essential to his existence? That, of course, we can never know with any approach to certainty. But it is significant that unspoiled savages to-day show at least as much interest in natural phenomena which do not affect their material interests as does the man in the street of a community which is called civilized. Since curiosity is certainly a primitive human instinct, and it leads to the acquirement of knowledge which is independent of practical usefulness, we can scarcely doubt that such knowledge was sought from a very early period of human history. But pure science cannot attain any considerable development in a society with little leisure. Where the conditions of life are so hard that everyone is almost wholly occupied in keeping body and soul together there is no time or mental energy available for the acquirement and organization of much knowledge for its own sake. In such conditions the great bulk of the knowledge that is acquired is practical knowledge, how to secure and extend control over that part of the environment which is of immediate practical significance, and then to make life easier and more comfortable. Thus arose the arts of food-gathering, of hunting and fishing, of stone implement making, of the taming and training of animals, of primitive agriculture, of weaving and pottery making, of building and primitive metallurgy. Chance observations, hit and miss experiments, the use of experience and primitive inductions, must have been the means employed. The improvement and elaboration of these various arts were the foundations of technology.

With the attainment of settled conditions and the advancement of technology, surplus wealth, that is, stocks of commodities not required for immediate use or consumption, could be accumulated, trade could develop, comfort could be increased, and eventually the luxury created which has been so marked a feature of the more elaborate civilizations. At the same time leisure became more abundant, at least for some members of the community. The arts of writing and of calculation were invented, and geometry and astronomy began to emerge as coherent bodies of knowledge. Practical needs such as trade, craftsmanship and the making of calendars were no doubt the immediate stimuli to these developments; but since we have every reason to believe that the mental constitution of the races which have occupied the Near East and Europe during the last four thousand years has been essentially constant throughout, it is impossible to doubt that the satisfaction in discovering new knowledge for its own sake, which is the driving force of research in pure science, must have been present in those early civilizations of the great river valleys of the Near and Middle East just as it was probably present in much earlier savage ancestors.

From at least the sixteenth or seventeenth century onwards there has been a body of scientific knowledge and theory which had *continuity*, and each generation could build upon the foundations laid by its predecessors. Discovery in science, hitherto isolated and sporadic, became a continuous process, and thus pure science, cultivated for its own sake, acquired an independent life. Needless to say, it was often influenced in volume and direction by social and economic as well as by intellectual conditions, and it often took technical problems as starting-points. But it was never wholly determined by such influences, and a great deal of it was undertaken with no reference whatever to the usefulness of its results. It is such research, in fact, that has ultimately led to the most striking practical discoveries and inventions. It is a striking fact that many discoveries made in the course of work undertaken with no practical aims have unexpectedly turned out to be keys to important applications of science in wholly different spheres. As scientific knowledge and theory become increasingly complex all sorts of cross-connexions between different departments reveal themselves, new branches arise, occupying hitherto unexplored ground between the older fields, and others cut across the old boundaries and take their material from several such fields. For this reason alone—the unexpectedness of discoveries and the unexpectedness of their applications—it would be disastrous to attempt the direction of all research to specific practical objects or to hamper complete freedom of investigation.

At the same time we must recognize that a good deal of work in pure science is unlikely ever to be of any practical use, though it may be of the greatest interest. Such, for example, is the detailed *history* of the earth, of its rocks, its vegetation and its animal life, and also a great deal of the detailed morphology of the plant and animal kingdoms. Should we discourage such work or deny it the necessary facilities? There are at least two good reasons why we should do nothing of the kind. In the first place we could never safely draw the line between work which might prove materially useful and work which certainly never would. If we once began to draw such distinctions we should put science into the power of those who clamour for results of immediate practical use and have no understanding of the complex and vital inter-relations of its different parts. The second reason goes much deeper, though it is connected with the first. Any such restriction of research would deny the right of men of science to investigate and increase our knowledge of the *whole* phenomenal world, and the right of the individual man of science to choose the field which his abilities and inclinations best fit him to explore.

The immense and complex development of pure science has the most far-reaching applications to human activity and profound effects on technology. Separating out, as we have seen, from the undifferentiated body of scientific discovery and technological invention of a former age, and acquiring an independent life of its own, pure science became the main source of all fundamental technological advance, while its full potentialities of application to other fields of human life are just beginning to be realized.

Historically, then, scientific theory arose piecemeal in one field and another, emerging from the growing structure of practical empirical knowledge or from the independent study of Nature. Gradually the separate pieces coalesced and began to form coherent bodies of theoretical knowledge. As it became securely established the structure of scientific theory acquired an independent existence and its description as 'pure science' became justified. On every hand it fertilized technology and made possible great advances and entirely new developments in the most various technological fields. Thus the term 'applied science' began to be used for the applications of pure science to the practical purposes of human life. Once established as an independent human activity, pure science assumed a continuity and a universal status which technology can never have, simply because all but the most elementary material human needs are partial and variable, so that human arts and crafts and manufactures rise and fall, appear and disappear, while organized knowledge of the world of Nature is permanent and free from such fluctuating conditions.

Technology is essentially 'patchy': technological research is occupied in solving unrelated practical problems of technique in the most various fields of human activity. Deeper penetration to underlying causes is not, as a rule, any concern of the technologist. All he cares about, as a technologist, is the solution of his immediate problem. The pure scientist, on the other hand, is perpetually seeking underlying causes, relations between things previously unsuspected of being related. This constant search is the essence of pure science, and when it succeeds great new fields are often opened up for exploitation by the technologist.

Recent writers who have envisaged not only technological but all scientific work as a 'social activity' determined by current social conditions and directed to the satisfaction of current social needs, have had no difficulty in demonstrating the general correlation of work that may be described as scientific with social structure and social requirements at various times and places. But to justify their sweeping conclusions they have had to lump together the whole body of empirical, technological and pure scientific knowledge of Nature and of human arts and crafts acquired throughout the ages; and they have misrepresented with a strange perversity the real nature and the essential psychology of scientific research. Up to the seventeenth century research for the sake of pure knowledge was on the whole sporadic, and the great bulk of the work described as determined by social conditions was technological work, though great scientific discoveries and generalizations were made here and there. Since then, as pure scientific work began to coalesce and acquire continuity, the determination of its direction by purely social factors has become less and less marked.

Leaving now the historical development of science we turn to the essential psychology of scientific work of various kinds.

No one contends that scientific men who engage in research are entirely uninfluenced by the social conditions of their time or by the particular conditions of their own early life and environment. It is obvious enough that these conditions must have a great effect on the formation of the scientist's mind and therefore on all his activities. The individual human mind has a certain specific hereditary endowment, but it does not work *in vacuo*. The material with which it is fed in childhood and youth and the influence of its particular environment must play a large part in determining its future activity.

The actual motives, both conscious and unconscious, which may cause a man to-day to embrace a scientific career of any sort are various and of different orders; the same, of course, may be said of any other human activity. For the vast majority there is the over-riding necessity of earning a living, and the particular work or career adopted will obviously depend on opportunities and prospects. A century ago a 'career' in science was open only to a very few. To-day opportunities are numerous and increasing, owing partly to the rapid growth and development of pure science but mainly to the enormous extensions of applied science and technology. The great majority of these openings lead only to laboratory posts the duties of which are those of what is sometimes called 'routine research', that is, to the making of tests, trials and checks on the instructions of a superior. A smaller but still a considerable number of posts are available in teams of research workers in industrial or Government laboratories engaged on the attempted solution of technical problems or sometimes of problems in pure science which are thought to have a direct or at least an indirect bearing on technical progress. This again is 'directed' work, just as much as that of a clerk in an office, though its intrinsic interest to the scientifically minded may well be much greater. To a few comes the possibility of promotion to the position of a subordinate director of the technical work of others or to the headship of a research team, and a very few may become directors of scientific departments or institutions where they will have much more opportunity of initiative, though very commonly such appointments are not made from the personnel of the particular laboratory, but often go to people from outside with a different sort of training. It is obvious, then, that to the vast majority of 'scientific workers' only technological work in which there is little freedom or opportunity for initiative is available.

There remains the possibility of employment in the teaching of science as a schoolmaster or at a university. A few schoolmasters find time and inclination for independent research, but the conditions are not often favourable. On the other hand, academic science teaching is usually combined with research and most of the current research in pure science is actually done at universities, much of it by university teachers.

Probably most of those who adopt one or other of these scientific careers—certainly those who enter the last-named—in order to earn a living have to a greater or lesser degree what is called the 'scientific bent'. This shows itself either as a strong interest in and desire to obtain organized knowledge of the natural environment—more often of some particular part of it, such as stars, rocks, animals, or plants—or as a specific interest in 'how things work' commonly seen in a small boy's keenness to find out how a machine is constructed and how its parts act.

What are the psychological factors underlying the 'scientific bent'? 'Curiosity' is the most general concept under which the first impulse to both kinds of scientific interest—in environment and in working mechanism—may be brought. Curiosity has been defined as "the desire or inclination to learn or know about anything, especially what is novel or strange". This is the adult expression of the curiosity which may fairly be regarded as a primary instinct of many higher animals, and is conspicuously displayed by human beings from a very early age. The human infant expresses it by making sensory contacts with the unfamiliar objects of its immediate environment, through sight, smell, taste, touch and manipulation. This is the primitive means of 'getting into touch with' or acquiring knowledge of one's surroundings.

The promiscuous curiosity of the young child, if it is not smothered by overwhelming repression but is controlled and canalized by the direction of intelligence, under the influence of growing experience, develops into the desire for organized knowledge of the objective world around him. This may take either or both of the two forms we have already distinguished, leading to interest in the 'natural history' sciences or in what has been called "general analytical science". Much can be learned from books and from oral teaching, but the unblunted instinct can be directly satisfied only by independent observation and experiment. It is the satisfaction by talented people of the desire for organized knowledge of the objective world that has gradually built up the permanent structure of pure science by successive descriptions and discoveries and by the conceptual welding of these into coherent bodies of scientific theory, the parts of which are constantly modified or replaced as fresh discoveries are made or deeper insight gained into the relations of phenomena.

The consistent object of pure scientific research is to establish a coherent body of objective knowledge and explanatory theory over the whole range of natural phenomena. In the course of this work new phenomena come to light, often by chance, and some of these can be exploited industrially. At the same time new principles are established which give rational direction and lead to crucial improvements in industrial processes that had hitherto been purely empirical. It is naturally physics and chemistry that have had the most extensive use in the field of technology, because industrial processes deal mainly with dead material. But biology has made important contributions to the two great practical arts of medicine and agriculture, and we are now on the verge of far-reaching social developments in which the applications of biological and psychological knowledge will play a commanding part.

We must not underrate the scientific importance of the enormous amount of work that is now done in technological laboratories attached to industrial firms, instituted or assisted by Government, and sometimes attached to universities. Not only is it necessary to improve and perfect established industrial processes and to learn how to exploit new scientific discoveries on an industrial scale, but also in the course of such work new scientific problems emerge which have to be solved if further advances are to be made. Some of these problems can be tackled in the technological laboratory itself, others are remitted to laboratories of pure science. Some technical laboratories, indeed, though founded solely for work in applied science, do in fact spend part of their time in pure scientific research on problems chosen from the particular field. Thus pure science and technology act and interact to the advantage of both, and so it must always be. While insisting on the essential distinction between them, we must not forget that the two are in one sense parts of a whole—a whole which has a fundamental unity given by the consistent application of the scientific method to every sort of problem, whatever the material and whatever the object. But the immediate object, which carries with it the specific motive, does determine the nature and scope of the results.

We have defined pure scientific investigation as the pursuit for its own sake of coherent knowledge of the phenomenal world, and the essence of its being is psychological. The motive actually at work here is nothing else than scientific curiosity, the satisfaction of which is the discovery of new objective truth—of new facts which can be fitted into the framework of pre-existing theory, which require its modifications or restatement, or which demand new theoretical formulations. Technological research has other primary motives. It is always concerned with the solution of a problem for practical purposes. Behind it may lie the motive of making increased profits, or the motives of saving labour, of curing or preventing disease, or of promoting the health and well-being of the population. Several different motives of this kind may be involved at one and the same time, but they are all concerned with direct practical ends.

We must recognize that human motives are often, if not generally, mixed. A man may want to benefit humanity and at the same time to increase his income, and the two very different impulses may be served by the same action. He may also at the same time be moved by genuine curiosity about the solution of his practical problem and experience the joy of discovery when he is successful. The professional scientist, entirely devoted to his research with the unique object of discovering new fragments of truth, cannot ignore the necessity of earning his living. If he were no longer paid he would have to find other employment. But these facts do not affect the truth that the structure of pure science has been built up by men who sought knowledge for its own sake without regard to practical ends, and the further truth that without their work modern technology would never have been possible. If the disinterested pursuit of knowledge were to cease, the structure of science would cease to grow and the springs of all fundamental advance in technology would be dried up. That is one reason why we must uphold the claim of free research in pure science to an assured place in our society.

But it is by no means the only one. Science is indispensable to our complicated material civilization: it has also intellectual, ethical, æsthetic, and ultimately spiritual values of a high order. In the first place, its constant touch with the world of external Nature in which laws are at work that are uninfluenced by the vain imaginings of human beings keeps our feet on the ground, and should help to check the constant human tendency to fly off into ideological fantasies and to imagine that subjectively constructed and emotionally biased ideal schemes can without more ado be successfully applied to the real world—a tendency responsible for a large number of disastrous political mistakes. I am far from contending that objective sanity is the monopoly of men of science. On the contrary, there is unfortunately abundant evidence that employment in scientific work and even distinction in research is no assured safeguard against domination by misleading idealisms. But there can be no doubt that the scientific habit of mind, with its insistence on preliminary careful and accurate survey of facts and its constant testing of theory by fresh observations and experiments, is the master key to the devising of successful techniques not only in the material but also in the social and political spheres.

One of the best hopes for the future welfare of humanity is the beginning of unbiased investigation of social facts, of social psychology as well as what may be called social anatomy and physiology, and the influence upon these of economic and other environmental factors. The great man after whom these lectures are named clearly saw, sixty years ago, that we needed a real science of society which he proposed to call 'sociology', but it is only recently that the study has begun to assume a genuinely scientific character. Its development is seriously hampered because its field is also an arena of the strongest human prejudices and passions, as the older sciences are not. For many of us an impartial consideration of the facts revealed is very difficult indeed, because our feelings and our private interests are too deeply involved. Ideological constructions, of which the Fascist and the Communist theories of the State are current examples, gain numerous adherents because they satisfy certain human ideals and seem to provide remedies for current evils. In some countries they have been imposed by force, since they also serve the interests of ambitious individuals. Behind a façade of pseudo-philosophy or pseudo-science are concealed gross inconsistencies and often gross cruelties. Yet we must recognize that aspects of sociological truth inhere in the most extreme social and political theories, or they would not appeal, as they do appeal, to so many people of goodwill. For it must never be forgotten that every social theory that appeals to people of goodwill contains at least some element which corresponds with a deep-seated social need, however far it is from being acceptable at its face value.

It is the business of the new scientific sociologist to evaluate these elements in the light of social and individual psychology, as well as to accumulate, marshal, and determine the significance of the widest range of sociological, economic and political facts. It is the ultimate business of our statesmen to implement their mature conclusions. Statecraft, like agriculture and medicine, is a very ancient art, and on one side it must always remain an art. Human beings cannot be managed entirely by text-book rules, however good the text-books. But just as agriculture and medicine have become and are still becoming, to their immense benefit, increasingly scientific, by the discovery of the laws underlying the processes involved in the growth of crops and in the human body in health and disease, so the organization and management of human populations, which is the concern of statecraft in its widest sense, can be made increasingly scientific by the proper use of sociological and economic data. The making and still more the application of sociological generalizations demand bold constructive imagination but at the same time the greatest caution and the coolest judgment, precisely because they are so easily influenced and distorted by our prejudices and passions. A certain amount of 'flair', of empirical procedure, and of trial and error experiment are necessary, just as they still are in agriculture and medicine.

We may well ask whether our statesmen are sufficiently equipped for their part of this task, whether their prevailing mentality is of the kind which can freely accept the scientific method and apply it to their problems, whether they are not too hopelessly biased by so-called vested interests, of class, party, or money. This is indeed a very serious question. Ministers and high officials are constantly betraying their indifference to, or their distrust of, the scientific approach to practical problems, even in such matters as agriculture and food values, in which it is clear that only responsible scientists who have made the relevant investigations have any right to an opinion. It is often only under the stress of war conditions that far-reaching changes are made which have long been urgently required and strongly advocated by all informed opinion.

I am not suggesting that these things can be made right by putting scientists into ministerial offices. The professional scientist is no better fitted than any other professional man to deal successfully with affairs, to excel in administration, or to manage human beings. Indeed if he has become eminent in some particular specialized branch of science it is likely that absorption in his subject will have rather secluded him from those contacts with the world which are desirable if not necessary for a successful administrator. Nor would it meet the case to require every prospective minister and public official of high rank to take a course in elementary science! It is not specialized scientific knowledge that is wanted here, but the scientific spirit, an intelligent appreciation of what science really is and what it can do. We may acknowledge that the habit of consulting experts has increased of late years. But in the modern State with its innumerable problems demanding scientific knowledge and investigation, the scientific approach should be a matter of course, and the existing temper of Government and official circles is generally averse from such an approach.

A glaring example is the treatment of agriculture in Great Britain by successive Governments since the War of 1914–18. The basic cure for the ills of British agriculture has been and is the scientific approach to its problems combined with a statesmanlike comprehension of the part the land should play in the national economy not only in producing food, but also in keeping a substantial and contented fraction of the population in contact with the fruitful earth. It is of no use to keep juggling with prices and quotas, or to keep changing the Minister. What is wanted is a man of wide outlook and scientific imagination, who has a general knowledge of the advances that have been made in agricultural research, a readiness to take into his intimate counsels the men who really understand them in detail, and the courage and drive to push through the necessary comprehensive plans. Some part of the appropriate measures have been taken in response to the urgent needs of war-time for an increased native food supply, but they cover only part of the field, and we should like to be sure that they will not be discontinued as soon as peace is proclaimed.

What is needed is a complete change of heart, and it does not seem that this can be brought about except by a change in education. The current education of the men who are entrusted with the forming of Government policies has almost wholly ignored and frequently despised science. Though giving a grudging recognition to its contribution to their material amenities, many of these men regard science with a mixture of dislike and fear—dislike because it seems to them hostile to the traditional cultural values they accept, fear because they are apprehensive that its tendency is to destroy those values. I am not one of those who depreciate classical or historical education. I should look with alarm at the prospect of severance of our culture from its historical roots—the philosophy, literature and art of Greece and Rome—or from the historical channels through which it has developed. But there is no reason whatever why a liberal education in the old sense should not be extended to include a sound introduction to scientific culture. Time could be found by reshaping the curricula and omitting the unessential. I contend that education cannot justly be called liberal to-day unless it includes an introduction to science and the history of science, simply because science is a vital part of the culture fitted to the contemporary world.

The reformed liberal education that I have in mind must begin in the secondary if not in the elementary school. It should be the normal school curriculum and in the hands of teachers thoroughly imbued with its spirit and significance. It has nothing to do with so-called 'specialization' in science, which at present begins at too early an age and may easily have a narrowing effect on the mind, as can unfortunately be seen in many scientists and technologists who have specialized too early and who tend to despise the other disciplines. Narrowness of cultural outlook is not, however, confined to scientific men. I have heard in this University of Oxford historians and others who are supposed to have had a liberal education express almost incredibly narrow and short-sighted views about the place of science in education.

We have just been considering the essential importance of science and the scientific spirit in the economy and service of the State. But the re-orientation of education I have advocated would do far more than produce a new and better type of minister and high official. It would broaden and vivify the minds of all who experienced it, at least of those at all able to benefit by a liberal education. Equally with literature and art, science has its own contribution to make to the development of the mind, its own distinctive quality engendered by the habit of dispassionate objective investigation and of respect for objective truth. The scientific mentality forbids the unconditional acceptance of views and formulæ represented as authoritative but often motived by traditional bias or by selfish interest. It teaches humility and submission to the logic of established facts, and counteracts the arrogance of human prejudice and wilfulness. This is an ethical as well as an intellectual contribution. I do not contend, of course, that this particular moral quality is confined to men of science; only that it is an essential part of the spirit of science and that the wider diffusion of that spirit will powerfully aid the growth of the virtue.

Finally there is the æsthetic aspect of science, which opens the mind to a far deeper and wider realization of the wonder and beauty of the universe. This is not a trivial claim though it may seem to some old-fashioned. A real and deep æsthetic satisfaction is brought by the constant contemplation of the infinite beauty of Nature, ranging from the galaxies of astronomical space through the marvellous diversity of scenery and of the living beings inhabiting the earth's surface, to the fascinating world revealed by the microscope and the still more minute phenomena dealt with by structural chemistry and intra-atomic physics. The gradual discovery of these things and of the laws which explain their relations, constantly reformulated and made to fit the observed phenomena ever more closely, is indeed a marvellous and majestic story, a story in which the human spirit can find refreshment and escape from the conflicts and tragedies of human life just as it can find escape and refreshment in the finest literature and the greatest music. The very impersonality of the subject-matter of science makes the refuge particularly complete. I recall that the group of men who afterwards founded the Royal Society sought refuge in the peaceful atmosphere of their experiments and discussions from the increasing political tension of London during the conflict between king and parliament. If the fashionable and facile charge of advocating 'escapism' is brought against me, I can only reply that the possibility of 'escape' in this sense is absolutely necessary to mental health and stability in the modern world.

Scientific culture, then, must take its place on equal terms beside the literary and artistic cultures. Entirely apart from its indispensability for the material comfort and the safety and health of modern urban populations, science has intellectual, ethical and æsthetic claims of a very high order. Its achievements are particularly characteristic of our own age. During the last half-century Europe has not produced poets or musicians who can compare with Shakespeare or Goethe, with Beethoven or Mozart, but it has produced several men whose discoveries are equal to the greatest in the history of science and very many of conspicuous talent, though not of genius, who have contributed between them a much larger body of sound scientific work than has been produced in any comparable period of history. Why then, we naturally ask, is science regarded with dislike and distrust by too many cultivated people who are supposed to have had a liberal education, and by the great majority of the population as a rather mysterious, esoteric agency which produces all sorts of marvellous mechanical contrivances but in which they have no part or lot? It is, I think, because scientific education has been kept in watertight compartments and almost exclusive stress has been laid on its material achievements to the neglect of its cultural values.

It may be objected that it would be impossible to give the masses of the population a liberal education in science, that science for the vast majority can never mean more than technical training in some particular branch that is materially useful. But if the hopes of progressive educationists are realized the aim of the future must be to put a liberal education within reach of everyone. It is my contention that a liberal education in any full and worthy sense must include a broad introduction to science, along with the other elements of knowledge and training which develop the mind, widen and deepen its scope, and do all that education can do to produce citizens equal to the opportunities and responsibilities of the future. It is perfectly true that only a minority of pupils will ever profit at all fully from such an education. A process of sifting must take place in the elementary school and in the secondary school, and only a small proportion of pupils will reach the university. Such a process exists now, though it is very imperfect: in the future we must give the fullest opportunities to all, irrespective of means or social class; but selection corresponding with ability and natural endowment there must always be. It is also clear that specialized training for the work of adult life is necessary, that it must be widely different according to the opening for different kinds of such work, and that it should be adapted to the natural bent and capacity of the individual. A great many pupils have no inclination or ability for scientific work, just as various others have no capacity for music, or for mathematics, or for languages, or for administration, or for craftsmanship. All this, of course, is the merest educational commonplace.

What I am advocating is that all should receive the elements of a liberal education, including a broad and real introduction to science in the secondary school, that for pupils of the greatest general ability specialization should be deferred to a later age than it is at present, so that general education could be carried further and a better and wider culture opened to the best growing minds. In this way a juster balance would be reached between the different aspects of human knowledge and a more secure foundation would be laid for a proper choice of occupation. Science would be placed in its proper light before the eyes of growing youth as one of the great channels through which man's creative powers can find expression, without the almost exclusive emphasis on its technological functions which is now prevalent. Most of those who chose a scientific career at any stage of their education would no doubt enter one of the great fields of the application of science to human use, both because the volume of employment in the technological field is and will continue to be much more ample, and because the qualities required in many such posts are much commoner than those necessary for the successful pursuit of pure research.

A comparatively small minority would engage in research or in teaching combined with research, as they do now, but this minority would be powerfully reinforced, in quality as well as in quantity, by drawing on hitherto untapped resources of the population. Comparatively rare as the combination of marked ability and strong inclination for research in pure science may be, there can be no doubt that it exists in many who at present have no opportunity of following their proper bent. The liberal school education I am contemplating should help to free the minds of those who follow any kind of scientific career from the distressing and harmful narrowness some of them now display. At the same time the acquirement of some knowledge of the real nature and significance of science should also help to abolish the equally distressing and harmful dislike and distrust of science among others to whom I have alluded.

Science is part, and by no means the least important part, of our cultural heritage, though it cannot, of course, satisfy the whole range of man's spiritual demands. We are often told that science alone is not enough, that its essentially mechanistic analysis of phenomena, not only the phenomena of the external world but of the mind itself as they are revealed by modern psychology, does not touch the essence of the human soul and cannot explain the highes values of which we are conscious. That I freely admit Certainly we cannot do without literature, art and music, nor can we dispense with religion in its wides sense. What I assert is that science, too, makes it own contribution to spiritual values, and that to limit its function to the material sphere is to impoverish our culture most disastrously.

The recent movement which exalts the materia function of science and denies the right of pure science to an independent existence is a kind of philistinism which plays into the hands of those who dislike and distrust science and are only willing to concede it material services. One of the leaders of this movement tries to bolster up his case by rather childish misrepresentations of the motives of scientific research, suggesting that scientific curiosity i "not particularly noble", that the joy of new discovery, the delight in establishing some new fragment of objective truth, of contributing, in howeve small a degree, to a clearer insight into the orde of Nature, are not the dominant impulses and feelings of the worker in pure science, that he i more often actuated by a desire to rise in the world and that he will gladly turn his back on research to become an administrator. Such contention are flatly contradicted by the experience of thos actually engaged in research, who have the bes opportunity of observing the dispositions and behaviour of their fellow-workers. That many scientist do in fact turn to administrative work in their late years is perfectly true. The ardent curiosity of th true investigator and his capacity to continue th strenuous though delightful mental work involved in continuous research often weaken as the mind loses its early vigour, though some minds retain them throughout mature life. Nor can we assert that th attractions of an easier life and a larger income ar negligible, especially to those who are conscious o the weakening of their earlier impulses. But th existence and effectiveness of these other motives in such cases do not affect the truth that the actua motives of pure research are highly characteristi and remarkably strong and pure. The evidence i plain to all who will look at the facts, unless they wish to believe the contrary.

The main contention of this school of thought is as we have seen, that research in science is alway governed, consciously or unconsciously, by curren social needs, and that we should now deliberately organize or 'plan' all research with the immediat object of continuing to satisfy those needs. Tha 'planning' must play a very large part in our futur social and economic life I should be the last to deny It is equally true that most technological work mus be planned and that even in the realm of pure scienc there are problems that can only be dealt with effectively by directed teams of workers. This applie particularly though not exclusively to much exploratory work and to preliminary surveys of wide scope But the highest type of research, that which has been productive of the most fundamental discoveries, i essentially the work of individual minds, freely dealing with their own chosen material. That is the evidenc of the whole history of science. If we desire to keep alive and vigorous the ultimate springs of ou material welfare, and—not less important—to maintain and extend the place of science in our culture we must jealously guard its freedom and its independence.

PORTABLE MASS SPECTROMETER

By JOHN A. HIPPLE, jun.
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THE mass spectrometer illustrated below was developed at the Westinghouse Research Laboratory in East Pittsburgh as a tool for some routine gas analysis problems. A rather complicated mass spectrometer had been used for this work; experience with this apparatus indicated that it would be desirable to have a compact, self-contained unit that could be moved to the position where a gas analysis was desired. The result of this was the development of the present instrument.

In contrast to the Aston type of high-precision instrument, high resolution is not so important here as high sensitivity and ease of measuring quantitatively the amount of ion current. For this reason the current is measured electrically. This mass spectrometer uses the focusing properties of a magnetic field described by Barber[1] and Stephens and Hughes[2,3]. Instruments using this principle have usually used a magnetic deflexion of 60°. Examples of this are the instruments of Bainbridge and Jordan[4] and Nier[5]. As is evident from Fig. 1, a deflexion of 90° has been used in the instrument here described. In the figure, the magnet has been withdrawn from its operating position to permit a better view of the tube itself. The 90° deflexion has been used for compactness, decrease in the ion path-length and simplicity of alignment and operation. The vacuum envelope is made entirely of glass and the electrodes are made of 'nichrome'. The tube is made in a jig and, when it is removed from the jig, no further alignment is necessary. The ions are shielded from the glass in the analyser region by means of a flexible 'nichrome' shield which fits inside the glass tube. The slits are of the order of 0·020 in. and the radius of curvature of the ions in the magnetic field is 5·0 in. With this geometry, the resolving power is about one mass unit in one hundred.

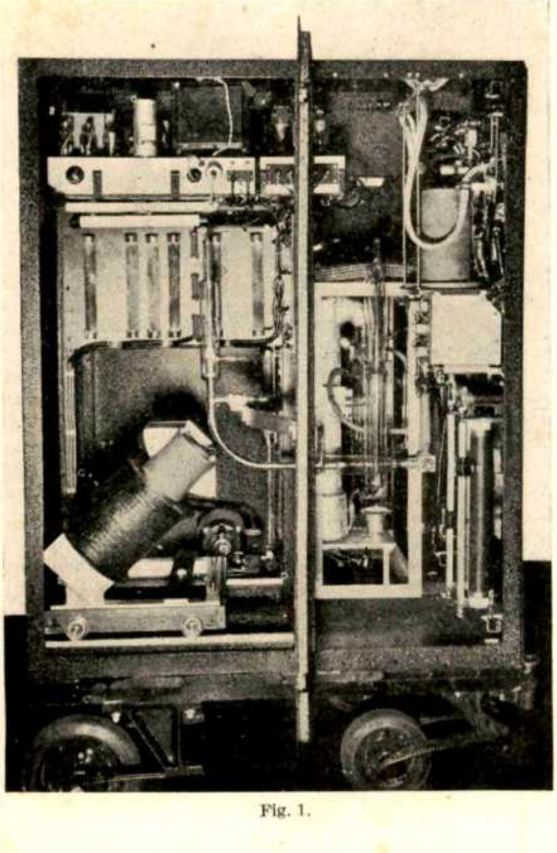

Fig. 1.

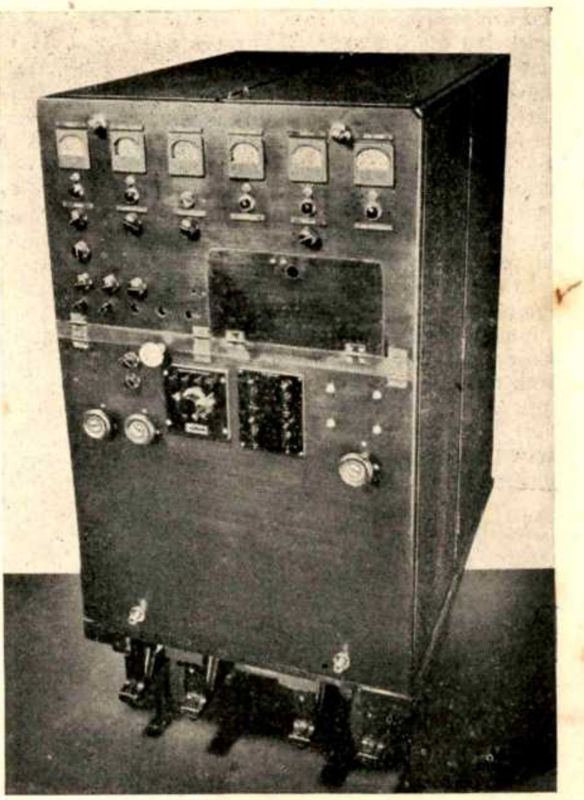

Fig. 2.

The magnet coils are wound with many turns of fine wire so that the maximum field is obtained with a voltage of 800 volts and a current of 0·100 amp. The power supply is an electronically stabilized rectifier shown at the top of Fig. 1. This 1,000-volt power supply also provides the accelerating voltage for the ions. Since the ion-accelerating voltage and the magnet voltage are provided by the same supply, an additional regulation is obtained as well as an economy in design.

The pumping system consists of two glass mercury diffusion pumps backed by a mechanical forepump. The diffusion pumps and the gas handling system for admitting the gas to the mass spectrometer are mounted on a sub-assembly which can be removed from the main assembly in a few minutes.

The ion current is measured in a conventional way by means of a sensitive electronic current meter. This instrument is mounted in an evacuated housing with sensitivity adjustment by a control on the front panel. The power for this instrument is provided by an A.C.-operated direct-current supply which is electronically stabilized. Another stabilized source provides the voltage for the electrons in the ionization chamber.

The entire apparatus is enclosed by a frame with steel panels except the front which is 'Micarta'. All sides and the top of the enclosure are provided with either hinged doors or panels which snap into position and are easily removable. In this way, there is ready access to all parts of the instrument. Fig. 1 is a view showing the side open, while Fig. 2 illustrates the complete unit ready for operation. It will be noted that the entire assembly is mounted on a truck for easy movement to any part of the building. Since the mass spectrometer is operated completely by alternating current, the only connexions to be made when the unit is in place is one to the A.C. voltage supply and water connexions for cooling the diffusion pumps.

In addition to the features of compactness, ease of operation and portability, the design permits ready shipment from one place to another, since all the component units may be removed in a short time from the main assembly. As an illustration, the first apparatus of this design was sent from Pittsburgh to New York (400 miles), operated in New York for a week and then returned to Pittsburgh without mishap and with very little trouble.

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[1] Barber, *Proc. Leeds Phil. Soc.*, **2**, 427 (1933).

[2] Stephens and Hughes, *Phys. Rev.*, **45**, 123 (1934).

[3] Stephens, *Phys. Rev.*, **45**, 513 (1934).

[4] Bainbridge and Jordan, *Phys. Rev.*, **50**, 282 (1936).

[5] Nier, *Rev. Sci. Inst.*, **11**, 212 (1940).

CARE OF WORKS OF ART IN WAR-TIME

By F. IAN G. RAWLINS

BY 'care' in normal times is probably understood due conservation and maintenance; this in fact is the elemental work which devolves upon curators of any collection of works of art. In times like the present, however, two novel aspects appear: one is protection against enemy action, and the other—a kind of dependent variable—is the greatly increased difficulty of ensuring proper care (in the usual sense) which the necessity for such protection tends to bring about. In other words, there is a distinct possibility of devising excellent 'cover' but at the same time exposing the treasures to such risks of damage and deterioration by inadequate transport and storage arrangements, that the verdict of posterity may well be, "If only they had been left where they were. . . ."

This is not merely to seek a nice balance in policy: sooner or later—perhaps sooner—a decision will have become vital; and if, as this article assumes, the plan amounts in effect to evacuation, then it is not a matter to be taken lightly. The hazards may indeed be severe. However, it is by no means my intention to make too much of them. Many can be overcome, and have in fact been overcome. But they are always there, and for the most part, experience to cope with them is not very extensive.

Clearly, evacuation is unjustifiable unless it is reasonably certain that the sum total of the chances of destruction (not only those due to hostilities) is thereby definitely reduced. There are, broadly, two alternatives: (1) dispersal, (2) deep shelters, for example, quarries, tunnels and so forth. The former amounts in practice to the use of country houses as repositories, sending a comparatively small number of objects to each; the latter is more drastic and will probably end in putting the whole collection underground in one place. Which of these methods is chosen will naturally depend upon considerations outside the scope of this contribution. The intention now is to discuss ways and means of securing a tolerable exile.

Dispersal

Technically, private houses, public halls and buildings of that category present a number of complexities, which make it most important to examine them in detail beforehand. For example, the flooding of basements (otherwise promising storages) is sometimes to be apprehended. The fire risk is usually considerable; appliances will almost certainly need augmenting. Moreover, for books and pictures especially, if the only way of dealing with an outbreak is by water, the curator may even be well advised to avoid the scheme altogether, since the damage suffered would probably be almost irreparable. Generally, the only effective safeguard is to have staff always available for instant salvage in case of fire. This implies the availability of a spare 'sanctuary'. The possible presence of dry-rot in timber floors should not be overlooked. In many instances woodwork can be adequately protected in occupied premises against mould growth and from becoming infested by bacteria by the application of a 10 per cent solution of copper naphthenate in paraffin. Fireproof paint or solution should be applied where desirable, both to wood and to any hangings or curtains used to exclude draughts or to form parts of air-locks. The majority of precious objects are most unlikely to be injured by war gases in vapour form. Splashes of the liquid, however, are almost sure to be fatal on books, manuscripts, pictures and textiles. 'Cellophane', oilskins, rubber fabrics, decreasing in effectiveness in that order, form reasonably sound protective coverings.

The most important factors of all are likely to be temperature and relative humidity (R.H.). It is usually considered that most museum materials and exhibits are well provided for at a temperature of 60° F. and 60 per cent relative R.H. Research on this subject is as yet insufficient to enable exact figures to be stated, but there is some reason to suspect that the traditional values of 60° F. and 60 per cent R.H. have been accepted more on account of the comfort of visitors to galleries than on behalf of the contents. While temperature *per se* is not of the greatest moment, relative humidity assuredly is. It seems likely that a range of between 50 and 55 per cent at around 60° F. is nearly ideal. Fluctuations in relative humidity such as commonly occur in most buildings at certain seasons of the year are most undesirable. They may produce strains leading to complete breakdown in some pictures (panels in particular), and to a lesser extent with other objects.

The control of relative humidity in war-time storages is exceedingly difficult; so much so indeed as to constitute a major problem. Obviously, fairly simple measures, capable of being implemented more or less on the spot, are all that can be reasonably expected. The main question is how to combine adequate ventilation with satisfactory constancy of relative humidity without elaborate machinery. It is easy enough to install some electric (preferably tubular) heating in a store room, and even to maintain an approximately level temperature, piercing doors or partitions to gain free air-circulation. But it will usually be found that the relative humidity varies over very wide limits, simply repeating the day and night changes that occur outside. The range may well be between 40 and 70 per cent or more. These are definitely dangerous limits.

In my experience there is only one course to adopt, and that to some degree at variance with customary methods. It is to seal off the storage chamber as effectively as possible from external influences, by stopping up doors, windows and cracks, and by hanging up heavy felt or similar material. Then small electric fans can be used, suitably orientated, to stir up the air inside the storage chamber itself. Fresh air can, of course, be admitted, when weather conditions are favourable, for a short time. Given reasonable heating, the relative humidity should be roughly constant. That is one point gained. If it settles down to a figure unduly high, say above 65 per cent (see later for the significance of this) more well-dried fabric may be introduced, or the temperature raised, so long as it does not in general exceed 70° F. If the relative humidity is too low, the temperature may be lowered a little, and wetted material suspended. It is probably prudent to avoid chemical drying agents like calcium chloride or phosphorus pentoxide in the same room as valuable objects. It will doubtless be noticed that the more hygroscopic material there is in the chamber the less sensitive does it become to abrupt changes of relative humidity.

Wherein this treatment differs from that commonly envisaged is its insistence upon constancy of relative humidity even at the expense of 'proper' ventilation. Naturally, if reasonable freedom from fluctuations in relative humidity can be obtained with air-flow from outside, so much the better; it appears, however, to be a most unlikely state of affairs to find (or even to attain) in war-time quarters.

Instrumentation may well be on a simple scale. Thermostats can be efficient for temperature control, but some method of testing the relative humidity regularly is essential. A psychrometer, or whirling hygrometer, is the obvious way, though recording instruments are useful adjuncts if periodically checked. At least they show the general trend.

Deep Shelters

These are inevitably in the nature of a long-term policy, and probably out of the question for the majority of institutions and private owners. Nevertheless, they are of great importance, and of considerable scientific interest. Clearly, no perishable material of value can be stored in quarries, caves, tunnels and such-like places without elaborate preparations on the site. The chief enemy is damp; the fire-risk, on the other hand, should be diminished compared with that for isolated houses. Other hazards, less obvious perhaps but sometimes no less severe on that account, are flooding, noxious vapours and gases, dust and falls of roof. These points are excluded from further discussion, since any proposed underground repository where such dangers exist would naturally be rejected out of hand.

We are left, therefore, with the ever-present problem of temperature and humidity control. One favourable factor may be expected to appear immediately, namely, that in many subterranean workings the temperature is approximately constant throughout the year; but the relative humidity may be high—around 90 per cent—and fairly even. Thus, it will be necessary either to erect buildings inside, or to block off suitable portions of the space and to 'condition' them as effectively as may be needed. Which method is adopted will depend largely upon the type of rock strata involved, and to some extent upon the shape and general lay-out of the place. The class of material to be stored will also weigh. If the natural temperature is low enough (around 45° F.), it may be possible to obtain the relative humidity required, say, 55 per cent at 60° F., by straightforward temperature control alone, without recourse to refrigeration, except perhaps temporarily, to hasten the process of drying out. If this is so, and electric power is available, as it supposedly would be in many cases—the project becomes quite tractable. In fact, conditions approaching the ideal can be realized relatively simply, given sound initial equipment and constant supervision. A stand-by generating plant in case of power failure is, of course, essential.

Repositories of this kind represent a type of scheme 'easier said than done', however; difficulties of a somewhat crude nature are apt to appear very early in the proceedings. One is often that of access, both to the site itself and to portions of it below ground which theoretically are the most advantageous to occupy. It should always be borne in mind that priceless and irreplaceable things are to be brought there (since such a plan would never be contemplated for minor exhibits), unloaded and perhaps unpacked, put in place and duly invigilated. In addition to which it may be necessary to allow for objects of great bulk combined with excessive fragility—altogether not an enterprise to be embarked upon too lightheartedly. A good feature awaiting us, however, is that quarry—and some other—adits are often far from straight, which is a great advantage in forming natural baffles against the propagation of blast.

General

There remain a few general considerations common to any programme of evacuation and war-time storage of valuables and perishable objects. One is that of avoiding the growth of mould or mildew. A relative humidity so low as 68 per cent has been found to permit of mould growth, especially at temperatures around 70° F., showing that raising the temperature is not in itself any security, if the relative humidity remains excessive. Good ventilation, or at least adequate air-movement, is a safeguard. Another matter concerns lighting. Some illumination is desirable as a check upon mould growth itself. In addition, for pictures less than about fifty years old, there is a tendency for the medium to turn yellow, especially if of a 'fat' nature. This process is favoured by darkness. For older paintings, oxidation is probably complete, and no colour change need be expected as the result of storage away from light, so far as the medium is concerned. Water colours and miniatures should always be stored away from light. Where possible, objects should be unpacked to facilitate inspection, and to give the best chance of air circulation.

Generally, there can scarcely be hard and fast rules, except perhaps to recollect that flooding, exposure to excessive relative humidity, attacks of mildew and—no less—inadequate or rough transport may bring about damage amounting almost to disaster. None of these things should stand in the way of seeking the safest place for works of art. But 'watch and ward' was never more urgent.

Some scattered literature on the subject began to accumulate as the result of the Spanish Civil War.

Since then two valuable contributions have appeared: (1) "Air-Raid Precautions in Museums, Picture Galleries and Libraries" (British Museum Trustees, 1939) and (2) "Preservation of Paintings in War-Time" by G. L. Stout (Fogg Art Museum, Harvard University, U.S.A., 1942). Meanwhile, data are being assembled from day to day as the result of experience in war-time repositories. Much of it would never have been obtained in years of peace. Some of it will doubtless be significant for future planning of museums and galleries.

OBITUARIES

Sir Daniel Hall, K.C.B., F.R.S.

SIR DANIEL HALL—long known simply as A. D. Hall—had an unusually wide circle of friends who will deeply mourn his death on July 5 at a nursing home in London.

He was born at Rochdale on June 22, 1864, and was educated at the Manchester Grammar School, where he already showed wide scientific interests and was equally keen on chemistry, physics and the field sciences, botany and geology. From Manchester he gained the Brackenbury Science Scholarship to Oxford and entered Balliol College in 1881. Here he was soon recognized as possessing entirely exceptional qualities and he lived a very full life. At no time was he a narrow specialist, least of all during these formative years at Oxford. Everything he touched he did well, whether it were science, athletics, or participation in the various movements then forming part of Oxford life. He rowed in the Balliol eight and he laid the foundations for those wide intellectual and artistic tastes which characterized him throughout his life and added so much to his personal charm. At Oxford, too, he was fortunate in his choice of friends, many of whom afterwards had distinguished careers. He did not remain at Oxford, but left in 1884 to become a science master at King Edward VI Grammar School, Birmingham, where he met his first wife, Mary Brookes, and wrote his first book, a little text-book for the use of his students. He soon gave up school teaching and for a time served as lecturer in the university extension movement then beginning; Kent and Surrey were his counties; they were then more rural than now. Here he became interested in agricultural education and he soon saw that if it was to be effective it must be systematic and continuous; occasional lectures were quite inadequate. He was able to persuade a very public-spirited gentleman, E. J. Halsey, of the soundness of his views, and Mr. Halsey saw that funds were provided for establishing an agricultural college. Hall knew the two counties well, and selected the old Latin school at Wye as the proper place; it was a medieval foundation with attractive old buildings that gave the setting he always liked so much. He took possession in 1894 and was able to add laboratories and new buildings without doing violence to the old ones.

Hall was ably supported by a group of able men: F. B. Smith, J. Percival, F. Theobald, T. R. Robinson and H. H. Cousins, and between them they worked out systematic courses on agricultural science and practice, and trained numbers of young men who afterwards held very important posts at home and abroad. Hall insisted that the teaching must not only be based on sound science but must also constitute a new science, always drawing on practical agriculture for its materials and its illustrations. He set the example by becoming a first-class grower of fruit, hops and flowers, especially roses, tulips and sweet peas; he could hold his own with any expert, and the farmers and gardeners of Kent quickly recognized him as a fellow-craftsman of outstanding distinction. He was equally successful in dealing with farmers; he was a remarkably shrewd observer and could quickly detect the flaw in management which had led to some unsatisfactory condition of crops or animals. The early prejudice against agricultural education could not stand up against ability of this sort, and before long the high position of Wye was assured.

Hall always recognized, however, that both the teaching and the advisory work then beginning to develop were limited by the amount and value of the science on which they were based, and very soon this began to be insufficient. There was at that time no provision for research; education was supposed by the administration to be a proper object for State aid, but not research, which was regarded as something entirely distinct and unrelated. Hall set himself to remedy this defect; he gave up Wye at the height of its success and in 1902 went to Rothamsted in succession to Gilbert; he found the whole place moribund, but with characteristic energy and devotion proceeded to put new life into it. He had neither staff, apparatus nor funds and was snubbed by the Board of Agriculture when he asked for a grant, yet his infectious enthusiasm attracted first men then money, until finally he had built up a compact team of research workers who opened lines of investigation that have since proved very fruitful. The Goldsmiths Company gave a handsome endowment for soil research and this lead has been followed by a long line of generous supporters.

Once again, however, Hall felt impelled to give up the work when he had got it well on the road to success. In 1909 Mr. Lloyd George set up the Development Fund for the purpose of developing agriculture and improving rural life, and he appointed a small Commission, including Hall, to administer it. Hall soon became the dominating figure and in October 1912 was induced to give up Rothamsted so as to devote his whole time and energy to the work. The full story has not yet been written, and reference can be made here only to that part dealing with research and education. It was agreed that agricultural research was to be greatly developed. Two methods were possible: the establishment of a large central research station covering all branches of agriculture on the model of the United States Department of Agriculture at Washington; or a number of smaller stations attached to the universities, where different branches of agriculture or agricultural science would be studied. The latter method was chosen, and there is no question that the decision was sound. Agricultural science has developed remarkably well in Great Britain as the result of the freedom conferred by the new arrangements, which were indeed the envy of scientific workers from other countries when they came over here. A very effective advisory service was also set up and the educational machine was greatly improved. Later experience has shown that these three services could well have been more closely linked, but there is no evidence that Hall was responsible for that defect. He certainly achieved a great amount of most useful constructive work.

Then in the War of 1914–18 came another change; at the crisis in 1917, when 'total war' was forced upon us and all peaceful activities had to be abandoned, Hall gave up the Development Commission and became Permanent Secretary to the Board of Agriculture under his old friend Prothero (afterwards Lord Ernle) as Minister. Here he was less happy than in his previous posts; he gave the impression that he found office routine very irksome; all his life he had been accustomed to prompt decision and speedy action, and in any event the times were unpropitious. When Bateson died in 1926 Hall accepted the directorship of the John Innes Horticultural Institution at Merton, retaining only a part-time connexion with the Ministry of Agriculture as its scientific adviser. Once more he was back in the atmosphere he loved; his coming, Darlington said, was like a breath of fresh air; and he rounded off a life-time of experience and observation of tulips and apples by producing two monographs which are not likely to be superseded in our time. He stayed on until 1939 and then retired, but only to change his occupation. He had always been interested in the Lord Wandsworth Agricultural School at Wantage, and as chairman of the governors he went to live there so that he might keep closer touch with its activities.

Few men can have lived a fuller life or one more helpful to the community. His influence will last long after our time, and the beneficial activities he started will go on bearing fruit, while his memory will be an abiding inspiration to all who had worked with him. E. J. RUSSELL.

Prof. D. la Cour

PROF. DAN LA COUR, director of the Meteorological Institute of Denmark, died at Copenhagen on May 19 at the age of sixty-five; his death will be deeply regretted by geophysicists throughout the world. During the past fifteen years or more he took an increasing part in international leadership in geophysics, the science for which above all others international co-operation is essential; at the time of his death he was president of the International Union for Geodesy and Geophysics. He was elected to this office at Edinburgh in 1936, and would normally have vacated it in 1939, but at the Washington conference of the Union, held just after the outbreak of the present War, new elections of officers were postponed; his advice and guidance in re-starting the work of the Union when peace returns will be greatly missed.

Prof. la Cour was born at Copenhagen on September 12, 1876, of a family of high distinction in Denmark; his father was a High School physics master. After completing his university studies at Copenhagen, he became an assistant of the Meteorological Institute in 1900, under the directorship of van Ryd; in the year previous to this he took part in a Danish auroral expedition, and during 1900 he was leader of this expedition. From 1903 onwards he took charge of the Department of Weather Services, and from 1920 also of the Magnetic Department. In 1923 he became director of the Institute. From 1908 onwards he lectured on meteorology at the famous Copenhagen Polytechnic Institute. In 1927 he was elected to the Danish Academy of Sciences, and in 1939 to the Danish Academy of Technical Science. He received also many honours from other countries, and held numerous important offices in international scientific bodies.

Among the services la Cour rendered to the advancement of geophysical observation, one of the greatest was connected with the plans for the repetition, in 1932–33, of the International Polar Year of 1882–83, when the leading nations co-operated in sending expeditions to various parts of the north polar regions, in order to make meteorological, magnetic, auroral and other observations throughout a whole year. The project for a renewal and extension of this work, with modern instruments and methods, in the jubilee of the original polar year, was mooted in good time for new expeditions to be planned, and in 1928 the International Meteorological Committee appointed a commission to organize the work. In 1931, however, the world economic crisis deepened, and there was danger of the project being abandoned; la Cour was foremost in withstanding this, and under his leadership, as president of the International Polar Year Commission, the great enterprise was carried through to success.

In facilitating afterwards the use of the large mass of new data thus obtained, la Cour likewise played an important part, with the enlightened generous support of the Danish Government. An international bureau was set up in his Institute, and there he organized the reproduction, on micro-films, of the magnetic and some other data. In this and his other work he and the skilled staff he gathered around him achieved first-rate results with great economy of money and effort.

He extended the scope of Danish observations in geomagnetism by establishing (in 1927) a permanent magnetic observatory at Godhavn, in Greenland (only 10° from the pole of the earth's magnetic axis), in addition to the long-existing Copenhagen observatory (now at Rude Skov). He also started a new series of Danish geomagnetic publications ("Communications Magnétiques") to supplement the Danish magnetic observatory yearbooks.

La Cour also aided geomagnetic science very greatly by his many improvements in the design of magnetic instruments, through which the accuracy and reliability of magnetic observations and records were notably raised. He overcame several inveterate difficulties that long hindered the attainment of the high degree of precision aimed at in geomagnetic measurements. One such difficulty was connected with the use of fine quartz suspension fibres. The usual clamping of their ends did not prevent slipping, and injured the fibres: la Cour, who was himself an adept in their manipulation, left a quartz drop at each end of the fibre, and placed each drop in a simple mounting of special design; subsequent light heating fused the quartz and provided a safe connexion with the holder. Again, the magnetic balance, for the continuous measurement of the vertical magnetic force, is exceptionally sensitive to slight changes in the position of the magnet relative to the knife edges on which it is balanced; la Cour avoided any such displacements by making the magnet, knife-edge and mirror in one piece, of tungsten steel, weighing in all only 2·5 gm. He also introduced a simple, ingenious and satisfactory method of optical temperature compensation for magnetic recorders. His improvements probably have valuable applications in other branches of observational and experimental physics. Only a few of his instruments and devices are mentioned here; a paper describing the latest of his instruments, for the measurement of the vertical magnetic force, reached England only a few days ago.

La Cour did much by example, precept and international intercourse to promote the improvement and extension of magnetic observations, and the intercomparison of magnetic standards. I was privileged in 1936 to accompany him on a tour with this object, to magnetic observatories and institutes in Sweden, Finland and Russia; he was a most kind, courteous and agreeable companion.

He was a tremendous worker, and was remarkable also for his capacity to inspire others with the same ardour, to an extent that perhaps sometimes surprised even themselves. His manner and his dignified movements suggested calm, irresistible strength.

La Cour was married and had one son and four daughters, who with Mrs. la Cour survive him. On his international journeys he was often accompanied by one or more members of his family, and in consequence there are many countries in which a personal sympathy with his family will be felt in their and our loss.

S. Chapman.

We regret to announce the following deaths:

Prof. J. C. Arthur, emeritus professor of botany since 1915 at Purdue University, and president in 1902 and 1919 of the Botanical Society of America, known for his work on the plant rusts, on April 30, aged ninety-two.

Mr. F. C. Baker, curator emeritus of the Museum of Natural History of the University of Illinois, corresponding member of the Zoological Society of London, on May 7, at the age of seventy-four years.

Dr. G. B. Batten, a pioneer of X-ray treatment, who was president during 1918 of the Röntgen Society, on July 9, aged eighty-one.

Dr. Charles R. Keyes, consulting mining engineer, founder and editor of the *Pan-American Geologist*, on May 18, aged seventy-seven.

Dr. M. W. Lyon, jun., pathologist of the Clinic, South Bend, Indiana, and president during 1931–33 of the American Society of Mammologists, on May 19, aged sixty-seven.

NEWS and VIEWS

Charles Blacker Vignoles and the Royal Society

At a meeting of the Royal Society on July 16, a gold snuff-box, once the property of Charles Blacker Vignoles, F.R.S. (1793–1875), was presented to the Society by his grandsons, Mr. E. B. Vignoles and Lieut.-Colonel W. A. Vignoles. Mr. Vignoles, in making the presentation, referred to the fact that in 1841 C. B. Vignoles presented to the Royal Society a fine portrait of Sir Isaac Newton, which had come to him as the result of a connexion between his mother's family and that of Sir Isaac. Mr. Vignoles said that his grandfather, who was of Huguenot descent, came of a long line of soldiers and was an orphan and a prisoner in French hands at the age of thirteen months. He was educated by his maternal grandfather, Dr. Charles Hutton, F.R.S., the mathematician, the author of "Hutton's Logarithms", in the preparation of which Vignoles assisted. As a young man he served for a time in the Army, taking part in the disastrous attack on Bergen-op-Zoom in 1814. Following the peace after Waterloo, he went to America, where he was engaged on survey work in South Carolina and Florida, then very little known. Returning to England in 1823 he was soon engaged in railway engineering, almost his first work being the first survey for the proposed Liverpool and Manchester Railway. In the course of a long career he carried out important work at home and abroad as a railway and civil engineer, including the great suspension bridge over the Dnieper at Kieff and a railway through the Cantabrian Pyrenees from Bilbao to Tudela, which with its sharp curves and bold moving of a river, struck a new note in railway engineering. The 'Vignoles rail', the flat-bottomed rail of his design still used all over the world, keeps his name familiar to railway engineers. Vignoles was elected a fellow of the Royal Society in 1855 and was president of the Institution of Civil Engineers in 1870–71.

The snuff-box, now presented to the Royal Society, was given to Vignoles by the King of Württemburg, in 1844, as a mark of his esteem, after Vignoles had advised the King on plans for the railways of the State. The snuff-box is of solid gold with a portrait of the King set in diamonds on the lid; inside the lid is an inscription in French giving the circumstances of the presentation and signed by Goes, Secretary of State of Württemburg.

Social Medicine at Oxford

The Nuffield Provincial Hospitals Trust, with the approval of Lord Nuffield, is to devote £10,000 a year for ten years to the creation in the University of Oxford of a University professorship of social medicine, and the foundation of an institute in which the professor will work. The purposes of the institute are: "To investigate the influence of social, genetic, environmental, and domestic factors on the incidence of human disease and disability. To seek and promote measures, other than those usually employed in the practice of remedial medicine, for the protection of the individual and of the community against such forces as interfere with the full development and maintenance of man's mental and physical capacity. If required by the university to do so, to make provision in the institute for the instruction in Social Medicine of students and practitioners of medicine approved by the Board of the Faculty of Medicine in the University of Oxford."

Scientific Men in War-time

A deputation arranged by the Parliamentary and Scientific Committee saw Mr. R. A. Butler, president of the Board of Education and chairman of the War Cabinet Scientific Advisory Committee, who was accompanied by Prof. A. V. Hill, on July 16, to urge the Government to set up a full-time scientific and technical joint board. This would have as its aim the fullest strategic use of scientific man-power and resources and the proper organization and exchange of scientific and technical information relating to the war effort. The deputation included Lord Hinchingbrooke, Lord Leverhulme, Lord Pentland, Lord Samuel, Sir Lawrence Bragg, Capt. L. Plugge, Prof. B. W. Holman, Dr. W. Wooldridge, Mr. J. H. Wootton-Davies, and representatives of the British Association of Chemists, Institute of Physics, Institute of Struc tural Engineers, Association of Scientific Workers, Institution of Mechanical Engineers and the Institute of Chemistry. The deputation clearly had as its object the views expressed in the leading article in NATURE of July 18.

Statistical ('Quality') Control of Production

SIR CHARLES DARWIN, director of the National Physical Laboratory, was the principal guest at the July meeting of the Scientific Instrument Manufacturers' Association of Great Britain, and spoke after luncheon about the use of statistical methods in the control of machine-production. He described some developments of these methods in mass-production in the United States; and the encouraging practical outcome of the discussion on the subject in April held at the Institution of Mechanical Engineers (see NATURE, May 23, p. 573). 'Quality control', as contrasted with simple 'limit' gauging (go or not-go) and the rigid specification of tolerances, applies the principles of the law of errors towards obtaining advance information of the tendencies in course of machine production, and towards correlating the users' requirements with manufacturing economy. Sir Charles gave impressive illustrations of practical results following adoption of this method.

Makers of scientific instruments are not ordinarily affected by considerations introduced by mass production methods; and there was some tendency to question the applicability of statistical method to quantities such as they usually handle. There was, however, considerable interest in its possibilities in regard to the quantities in which they are now making many military instruments. Several speakers attached much importance to letting the operatives see their working charts, describing the stimulus value of bringing home to the workers the results of the work they are doing. There was a suggestion that the service inspection departments stand in greater need of education in statistical principles than do the manufacturers; but the speaker was reassuring about official sympathy in this direction.

British and Russian Naturalists

THE following telegram was received by the Linnean Society of London from the Moscow Naturalists' Society on July 11: "Linnean Society, London. Council of Moscow Naturalists of which Charles Darwin was honorary member has been instructed by its members assembled at meeting in commemoration of centenary of appearance of his Origin of Species to convey their ardent greetings to Linnean Society. In midst this great ordeal which has fallen to lot of democratic countries and of science Moscow Naturalists' Society oldest scientific society in Soviet Union pays reverent tribute to memory great scientist and humanist and firmly believes in early victory of our countries over Hitler tyranny". Academician Alexander Fersman, Professor Serge Ogneff, Professor Vera Varsanofieva (vice-presidents), Professor Serge Lipshitz (Secretary).

The following telegram was sent by the Linnean Society of London in reply on July 16: "Moscow Naturalists' Society, Moscow. The Linnean Society of London heartily reciprocates your friendly greetings and joins in tribute to memory of Charles Darwin most illustrious member on our roll. The magnificent resistance of the Russian people to Nazi aggression has aroused deepest admiration in our country. We share your confidence in early victory of the United Nations and are with you to the end". E. S. Russell (President).

Polish Science and Learning

ATROCITY follows atrocity so rapidly on the continent of Europe that public conscience is only momentarily aroused by any fresh crime made in the name of the Nazi 'New Order' in Europe. The Polish nation has been the special object of German fury, and Polish scholars and men of science in exile feel it is their duty to remind others of what is at stake. *Polish Science and Learning*, which resembles *Nauka Polska* (Polish Science) that recorded during 1919–39 the trends and progress of general and natural science, has been founded by a group of Polish savants now working in Great Britain and representing seventeen universities, academies and research institutes. Its object is to record the continuation of their researches as well as to direct attention to events in their unhappy country, where all universities and colleges and indeed all educational establishments above primary schools have been closed. Of the hundreds of periodicals covering all branches of pure and applied science, not one is left. Practically the whole of the rich Polish literature is denied to the nation to-day. In 1940 the Germans issued a 49-page list of books banned from all libraries in Poland. It included the names of 1,500 authors and the number of works cited was about five thousand. Meanwhile, Polish university life is being maintained in Britain and the United States. Many professors and lecturers are carrying on researches at British universities and institutions, and an imposing list of publications has already resulted. In addition, a complete Polish Medical School was established at Edinburgh in 1941. Also, an autonomous Polish Institute of Science and Learning has been set up in New York to act as a publication centre and to arrange courses of lectures and discussions. There is thus a continuity of Polish scientific work, and a body of savants is ready to resume duties at home when their land is liberated.

Cotton Research in East Africa

THE report of the administrative council of the Empire Cotton Growing Corporation submitted to the twenty-first annual general meeting on June 2 refers to a report by the Scientific Advisory Committee which outlines a scheme for the establishment by the Corporation of a Central Cotton Research Station in Uganda. Careful examination of the work being done by the present experiment stations has confirmed the view expressed in last year's report as to the value for the Empire of such a station in East Africa, at which fundamental scientific investigations could be carried out arising from practical problems that confront cotton-growing in those Dominions and Colonies in which the crop is cultivated on a commercial scale. The functions of such a station are defined as to carry out research on problems of cotton growing, especially on those of common interest to several territories. Such work should have a practical bearing on cotton production, and cotton should be treated as an element in peasant agriculture, compatible with food production, the prevention of erosion and the maintenance of soil fertility. Its functions would also include the co-ordination of certain activities of the Corporation's stations elsewhere in Africa, and if requested, of stations working on cotton and staffed by the Colonial Agricultural Service.

Though no distinction should be drawn between fundamental and immediate research work, an orderly division should be made between general and local problems, the former being incorporated in the programme of the research station and the latter suggested for investigation at other stations. The research station should collaborate with the latter in the particular application of general results to local conditions, and its work should also be framed so as to be complementary to that of the Departments of Agriculture. The Corporation hopes to be able to provide the finance necessary for the recurrent expenditure of the research station, and the Colonial Office has been asked to approve in principle a grant being made after the War from the Colonial Research Fund to cover the capital cost of the station in land, buildings and equipment. The report of the Council also includes some notes on the work during the year of the Genetics Department and the Physiology Department of the Research Station, Trinidad, and on research work carried out at the Universities of Cambridge and Manchester, the Imperial College of Science and Technology, and the Rothamsted Experimental Station.

Folk-lore Treatment of Sneezing

THE March issue of the *Bulletin of the History of Medicine* contains an interesting article on contemporary folk-lore treatment of sneezing by Dr. Leo Kanner of Baltimore, who classifies the folk-lore remedies for this condition in the following categories: (1) suggestions, general or specific, of the healers whom the patient should consult; (2) metaphysical cures and prayers, mental equilibrium and magnetic treatment; (3) cure through fright; (4) external remedies, such as pressing and rubbing; (5) local applications to the nasal mucous membrane; (6) spraying, inhaling, snuffling, smelling and gargling; (7) exhaling; (8) remedies *per os*; (9) complicated recipes; and (10) hygienic and dietetic measures. Dr. Kanner comes to the conclusion that contemporary folk-lore, despite its apparent simplicity, is a highly complex mixture of a number of different ingredients which consist of the retention of beliefs and practices dating back from the earliest times; borrowed but not fully understood gleanings from current scientific medicine; survival of methods which were part of the repertory of practitioners two or three generations ago; and references to present-day healing cults.

Prophylaxis of Malaria in Argentina

IN a recent paper (*Bol. Of. San. Panamericana*, 21, 233; 1942) Dr. Hugo J. D'Amato, secretary of the National Department of Hygiene at Buenos Aires, states that during 1940, and especially from January until April, there was a decided increase in the number of cases of malaria in North Argentina, where the disease is endemic, with the exception of those areas protected by the public health services, thus proving the efficiency of the methods applied. More than 170,000 patients were examined by the services of the National Department of Health and more than 20,000 in the provincial and municipal institutions; this is an increase of 5 per cent on the figures of the previous year. *P. falciparum* accounted for 33 per cent of the infections as compared with 12 per cent for the previous year. In 1940, 11,200 more patients were treated than in 1939 and more dispensaries were opened. About 1,600 kgm. of quinine are distributed every year, health education is carried out intensively, nearly 350,000 pesos are set aside yearly for preventive work, and private donations add 50,000. In 1940, 30,250 houses were visited, in 8,210 of which mosquitoes were found, chiefly *Anopheles pseudopunctipennis* and also a few *A. arsimaculatus*, *A. œgyritarsis*, *A. perizi* and *A. albitarsis*. Drainage, filling in, and other sanitary procedures were carried out on a large scale. More than 200,000 litres of petroleum and 70,000 kilos of Paris green were used.

Public Health in Chile

THE March issue of the *Boletin de la Oficina Sanitaria Panamericana* contains a survey by Dr. Pedro Aguirre Cerda, president of Chile, on the present state of public health in the Republic. Since the end of 1939 the country has been free from epidemic disease with the exception of one or two sporadic cases of typhus. Whereas, in 1938, 70 per cent of the conscripts serving in America contracted malaria, in 1940, there was not a single case. Special attention has been given to maternal and child welfare, and it is hoped that the present high infant mortality will be considerably reduced in two or three years. A scheme of medical attention is being planned to provide for mothers from the onset of pregnancy and for children from birth until they are able to work. The acute housing problem is being solved by providing hygienic and comfortable homes for workers at a low cost. Popular restaurants served approximately 2,000,000 meals to 1,000,000 persons in 1939, and 4,000,000 meals to 1,200,000 in 1940; 5,000,000 pesos have been allocated to aid deserted mothers and children as well as other handicapped persons.

Earthquake in Spain

AN earthquake was felt in Granada in southern Spain early on July 12. According to human perception, the shock lasted for about ten seconds, although no damage or casualties have been reported. The epicentre was estimated to have been some eighteen miles from the city, and a slighter aftershock was felt a few minutes later. Since earthquakes show a marked tendency to recur in areas once affected, it is not surprising that earthquakes such as this one should occur. In southern Spain such shocks and smaller tremors are by no means infrequent, though probably one of the largest earthquakes to occur in Spain was that on November 1, 1755, near Lisbon, the written records of which were studied by the late Dr. C. Davison.

Earthquakes in South America

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the epicentres of two recent South American earthquakes. From seismographic reports from twenty-two observatories, the epicentre of the earthquake of May 14 at 2h. 13·3m. U.T. provisionally turned out to be near lat. 1° S., long. 79° W. This is near the town of Riobamba, in Ecuador. From reports from five stations, the provisional epicentre of the earthquake of May 14 at 8h. 39.0m. U.T. turned out to be on the bed of the Pacific Ocean, off Tumaco in Colombia. Both epicentres are in well-known seismic regions.

Earthquakes in New Zealand

DURING April 1942, ten strong distant earthquakes were registered on the seismographs situated in various parts of New Zealand (New Zealand Seismological Report, Provisional Bulletin No. P-122). Additionally, there were twenty earthquakes which were felt in some part of the islands during the month. The strongest were on April 25 at 4h. 53·2m. U.T., which was felt with intensity 6 on the Rossi-Forel scale in the southern Hawke's Bay and Manawatu regions, and on April 26 at 00h. 26·3m. U.T., which was felt with intensity 5 (R.F.) in the neighbourhood of Upper Takaka. Other regions affected were Cook Strait and Christchurch, April 1, Hastings, April 2, Rotorua, April 8, Wairoa, April 18, Naseby, April 28, and Tokaanu, April 30. Minor activity was also recorded on several days at the observatories of Wellington, Christchurch, Auckland and Arapuni.

The strong New Zealand earthquake of June 24 which occurred at about 11.18 p.m. (local time) in the neighbourhood of Masterton (NATURE, July 4, p. 18) was strongly recorded with a full suite of pulses at Kew Observatory. According to the provisional interpretation of the seismogram at Kew, the vertical record received $ePKP_1$ at 11h. 36m. 32s. U.T. on June 24. On this record a maximum ground movement at Kew of 86 μ was attained at 13h. 04m. 15s. U.T. and the recording finished at about 17h. U.T.

Electrical Equipment of Buildings

THE Institution of Electrical Engineers has just issued recommended War Emergency Relaxations of the Regulations for the Electrical Equipment of Buildings (11th Edition), copies of which are available from the Institution free of charge, except where a number of copies is required. Regulation No. 304 relating to voltage-drop is amended, and the current ratings of certain cables are increased. The current-rating tables affected are Nos. 5 to 9 inclusive and 16. Two new tables, 5(A) for small single-core cables of earthed concentric wiring, and 10(A) for mineral insulated cables of 0·007 sq. in. cross-sectional area and above, are now added. Table 10(A) takes the place of Tables 10, 11 and 12 referred to in clause 302(B) for the cables in question. The purpose of the relaxations is to economize in materials.

Beit Memorial Fellowships for Medical Research

AT a recent meeting of the Trustees of the Beit Memorial Fellowships for Medical Research, Dr. A. N. Drury, Huddersfield lecturer in special pathology in the University of Cambridge, was appointed to the Advisory Board in succession to the late Prof. A. J. Clark. The Trustees noted with pleasure the election this year of three past fellows to the fellowship of the Royal Society, namely, E. Hindle (junior fellow, 1910–12, and senior in tropical medicine, 1927–33); F. M. Burnet (1926–27) and A. R. Todd (1935–36). Of the twenty-eight present fellows, there are now fourteen seconded for whole-time war-work.

The following elections have been made, with permission for each fellow to be seconded at any time for war duties: *4th Year Fellowship* (£500 a year). Mr. E. G. L. Bywaters, to continue his studies of crush injuries in relation to kidney function, at the British Postgraduate Medical School, London. *Junior Fellowships* (£400 a year). Dr. D. Herbert, to study the biochemistry of toxoids for active immunization against gas gangrene, at the Dunn Biochemical Laboratory, University of Cambridge. Dr. F. W. Landgrebe, to study the separation of posterior pituitary hormones, and their clinical uses, at the Medical School, University of Aberdeen.

The Night Sky in August

THE moon is new on August 12d. 02h. 28m. U.T. and full on August 26d. 03h. 46m. The following conjunctions will occur during the month: Aug. 2d. 04h., Venus in conjunction with Jupiter, Venus 0·3° S.; Aug. 6d. 09h., Saturn in conjunction with the moon, Saturn 3° N.; Aug. 9d. 05h., Jupiter in conjunction with the moon, Jupiter 4° N.; Aug. 9d. 21h., Venus in conjunction with the moon, Venus 4° N.; Aug. 13d. 15h., Mars in conjunction with the moon, Mars 0·7° N.; Aug. 19d. 13h., Mercury in conjunction with Mars, Mercury 0·01° S. Mercury is in conjunction with the sun on Aug. 2 and is an evening star at the end of the month. Venus is still a morning star. Mars is too near the sun for observation. Jupiter is a morning star in the constellation of Gemini. Saturn is a morning star north of Aldebaran. Occultations of stars brighter than magnitude 5 are as follows: Aug. 6d. 01h. 41·9m., 71 Tauri, R.; Aug. 6d. 01h. 58·8m., θ^2 Tauri, D.; Aug. 6d. 02h. 09·8m., θ^1 Tauri, D.; Aug. 6d. 02h. 44·0m., θ^1 Tauri, R.; Aug. 6d. 02h. 54·9m., θ^2 Tauri, R.; Aug. 30d. 00h. 49·4m., ν Piscium, R.

There will be a partial eclipse of the sun on Aug. 12, invisible at Greenwich. On Aug. 26 there will be a total eclipse of the moon, partly visible at Greenwich. The circumstances of the eclipse are as follows:

Moon enters penumbra Aug. 26d.	01h.	01·7m.
„ „ umbra	02	00·5
Total eclipse begins	03	00·9
Middle of eclipse	03	48·0
Total eclipse ends	04	35·0
Moon leaves umbra	05	35·3
„ „ penumbra	06	34·0

The Perseid meteor shower will attain its maximum during Aug. 10–12.

Announcements

PROF. J. W. H. EYRE, emeritus professor of bacteriology, University of London, has been elected president of the Royal Institute of Public Health and Hygiene in succession to the late Sir Thomas Oliver. Prof. Eyre was senior vice-president and one of the founders in 1903 of the Institute of Hygiene, which amalgamated in 1937 with the Royal Institute of Public Health to form the present Institute.

AT a meeting of the Yorkshire Federation of Museums and Art Galleries, recently held at Huddersfield, Mr. T. Sheppard, formerly director of the Museums at Hull, was elected an honorary life member, "in recognition of his services to the International museum movement, and to the Yorkshire Federation in particular".

THE following appointments have been made in the Agricultural Department of the University of Leeds: Mr. J. B. Mackinson, honorary assistant to the Veterinary Investigation Officer; Mr. P. H. Brown, lecturer in horticulture; Miss E. M. Parker, assistant lecturer in agricultural bacteriology; Miss Margaret W. Crunan, instructor in rural domestic economy; Miss Elizabeth Darley, temporary instructor in poultry husbandry.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Number of Primes and Probability Considerations

SEVERAL months ago Lord Cherwell[1] directed attention to an apparent paradox which arises if one attempts to use probability considerations to determine the asymptotic density of prime numbers. The argument is this: The probability that a large number is not divisible by a prime p is $1 - \frac{1}{p}$. If we assume that such probabilities are independent for all pertinent trial divisors, we obtain as the density of primes near N^2 the value $\prod_{p<N}\left(1 - \frac{1}{p}\right) \sim \frac{1}{e^{\gamma} \log N}$; the correct value, however, is $\frac{1}{2 \log N}$.

It is, of course, possible for mathematicians to dismiss such a question at once as unworthy of any consideration[2]. On the other hand, there are probably few physicists who would not feel at first sight that this is an eminently reasonable—perhaps even the only 'really' reasonable—approach to the problem, "How likely is a number near N^2 to be prime?". This feeling carries with it an obligation to try to account for the difficulty.

As Lord Cherwell remarks, the discrepancy must come from the fact that the probabilities are not independent. That they *may* not be independent is obvious. It can easily be shown that $\prod_{p<N}\left(1 - \frac{1}{p}\right)$ is the *mean* density of numbers not divisible by any prime less than N, in the sequence of numbers 1, 2, 3, . . . $\prod_{p<N} p$; but numbers near N^2 are in a highly special position—very near the beginning—in this long sequence, so that there is no basis for identifying this particular *local* density with the mean density.

Now, the density near N^2 of numbers which are divisible by p but not divisible by any smaller prime is $1/p$ times the density near N^2/p of permissible quotients: that is, of numbers not divisible by any prime less than p. If $p > N^{2/3}$, such quotients must themselves be prime; for $N^{1/2} < p < N^{2/3}$, they may be either single primes or products of two primes, each $\geqslant p$; and so on.

Thus the density of primes near N^2 must be equal to: [density near N^2 of numbers not divisible by any prime less than $N^{2/3}$] minus $\left[\sum_{N^{2/3}<p<N} \frac{1}{p}\right.$ (density of primes near $\left.\frac{N^2}{p}\right)\Big]$. If we take $\prod_{p<N^{2/3}}\left(1 - \frac{1}{p}\right)$ as a rough value for the first term, and evaluate the second by using the formula $\frac{1}{\log u}$ for the density of primes near u when $N^{2/3} < u < N^{4/3}$, we get

$$\prod_{p<N^{2/3}}\left(1 - \frac{1}{p}\right) - \int_{N^{2/3}}^{N} \frac{du}{u \log u \log \frac{N^2}{U}} =$$

$$\frac{3e^{-\gamma} - \log 2}{2 \log N} = \frac{0{\cdot}9913.}{2 \log N}$$

By replacing the assumption that the probabilities are independent by an asymptotically correct procedure in part of the range, we have reduced the error in the result to less than 1 per cent.

If the assumption that the probabilities are independent is used only as far as $N^{1/2}$, the density of numbers eliminated by trial divisors between $N^{1/2}$ and $N^{2/3}$ is given by a double integral. The result obtained for the density of primes near N^2 is $\frac{1}{2 \log N}$ times the factor

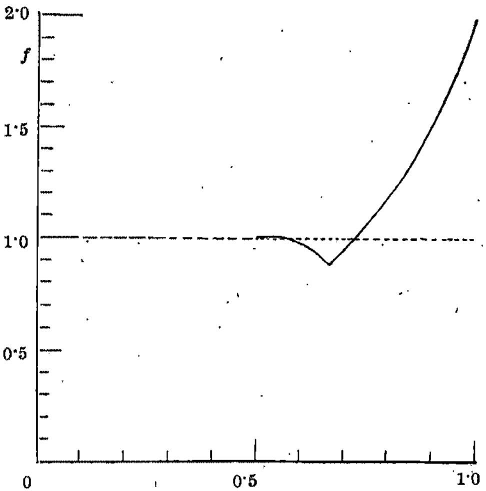
$$4e^{-\gamma} - \log 3 - \log 2 \,.\, \log \tfrac{3}{2} + \tfrac{1}{2} \sum_{k=1}^{\infty} \frac{1}{k^2 \cdot 4^k} =$$
$$1{\cdot}0000050.$$

It seems that the breakdown of the assumption that the probabilities are independent becomes considerable only for the larger trial divisors, and that we have a correct procedure to replace it there.

Another way of expressing the situation is as follows: The probability that a number n is divisible by a prime p is $1/p$, if concerning n we know only that it is large compared with p. If we know that n is *near* N^2 and *not divisible by any prime smaller than* p, then the probability that n is divisible by p is not $1/p$, but f/p. For $N \gg 1$, the factor f is a function of $\xi = \log p/\log N$; it vanishes for $\xi > 1$, and for $\xi < 1$ it can be calculated by using the sort of considerations described above. We find that

$$f(\xi) = \frac{2}{(2 - \xi)\,[1 + \log (2 - \xi) - \log \xi]}, \quad \tfrac{2}{3} < \xi < 1;$$

for $\frac{1}{2} < \xi < \frac{2}{3}$ a single numerical integration is required to determine f; and for smaller values of ξ the calculation is more complicated and has not been carried through.



The behaviour of the function f between $\xi = \frac{1}{2}$ and $\xi = 1$ is shown in the accompanying figure, and makes it seem extremely plausible that f is almost exactly unity for $\xi < \frac{1}{2}$—that is, that the trial divisors smaller than $N^{1/2}$ are practically independent in their action on the numbers near N^2. Since $f(1) = 2$, the last and largest of the trial divisors finds roughly twice as large a proportion of victims among the survivors of the previous trials as it would in a virgin population.

The considerations given here are, of course, of no value as a proof of the $1/\log u$ distribution of primes.

That theorem remains the property of students whose approach is more subtle than "probability considerations". The only use of the above remarks is to satisfy those who feel that the failure of the probability argument needs some elucidation, by showing how the factors do indeed tend to "avoid one another". I am grateful to Lord Cherwell for directing the attention of readers of NATURE to this question, and hope that he will find this answer satisfactory.

W. H. FURRY.

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[1] NATURE, 148, 436 (1941).

[2] Hardy and Littlewood, *Acta Mathematica*, 44, 36–37 (1923), especially footnote 4, p. 37.

I AM grateful to Prof. Furry for his sympathy with the outlook of a mere physicist and for the light he has thrown upon this matter. Prof. E. M. Wright, some months ago, sent me privately a proof on somewhat similar lines that the probabilities could not be independent for primes greater than $n^{0 \cdot 76}$. Prof. Furry has carried the process a step further and shown the degree of divergence.

The mode of attack is not unlike one which I had pursued earlier without success. If ε is small compared with n, there seems no apparent reason why the density of composites containing prime factors less than n should not be the same in the neighbourhood of $n^2 + \varepsilon$ as it is in the neighbourhood of n^2. But in the neighbourhood of $n^2 + \varepsilon$, over and above the composites whose smallest prime factors are less than n, we must take account of the composites whose smallest prime factors lie between $\sqrt{n^2}$ and $\sqrt{n^2 + \varepsilon}$. Pursuing this line of thought, the following equation for the number of primes in the neighbourhood of z seems to emerge:

$$f'(z)_{z=n^2} = -\left(\frac{f(z)}{2z}\right)^2_{z=n}.$$

At first sight this seems promising since it is obviously satisfied by $f(z) = \frac{1}{\log z}$. But unfortunately it is also satisfied by the expression $f(z) = \frac{a}{z^{a/4}}$ where a may have any value, and I have not so far succeeded in finding any simple argument which excludes solutions of this type.

CHERWELL.

Christ Church,
Oxford.

Relationships of some Primitive Tetrapods

IN the final draft of an earlier letter[1], the occurrence of Diadectes in the late Stephanian was omitted by mistake. A misprint also needs correction, the index to reference 7 (par. 5, line 8) should follow "Moodie" (same line).

The opening sentence of par. 4 requires further comment. A somewhat similar structure is found in the Lower Carboniferous (Viséan) Otocratia, from the Burdie-house Limestone of Midlothian[2]. This skull has the otic notch nearly closed, and with one exception the skull-pattern (so far as it is known) is remarkably similar to that of Microbrachids and primitive Captorhinomorphs. The exception is the larger size of the postparietals, which exclude the parietals from contact with the tabulars. The structure of the homologous region in Osteolepids, Elpistostege, Ichthyostegids and most Stegocephalia is similar and undoubtedly represents the primitive condition. In Anthracosaurs, Microbrachids and early reptiles the postparietals are smaller, and the parietals and tabulars meet; in these forms the posterior part of the skull shows great shortening. It is therefore possible to regard the difference in structure between Microbrachids and Otocratia as due to increasing specialization of the former, for which Otocratia could thus provide a suitable morphological ancestry. In these forms the broad contact of the parietal and postorbital separates the supratemporal from the postfrontal, there is no separate intertemporal, and the orbits lie in front of the middle of the skull.

Otocratia is remarkably similar in skull-pattern to the Ichthyostegids and Elpistostege, except that its otic notch is obliterated by downward rotation of the tabular. The structure in Otocratia regarded by Watson as an internal nostril is too anteromesially placed, and appears to be the anterior palatal vacuity, bridged (as in some Osteolepids) by a strong median bar from the premaxillaries. The "advanced" features noted by Watson in this genus are found also in Ichthyostegids[3], and form indeed a very sharp contrast to early Embolomeres. I regard Otocratia as probably derived from Ichthyostegids. Its structure is suitable for the morphological ancestry of the Dinantian Adelospondyls described by Watson[2].

It is noteworthy that the earliest-known Embolomerous types (Loxommoids and Anthracosaurs) come from strata of Namurian age, while Otocratia, the Adelospondyls just mentioned and an undetermined "Lepospondyl"[3] are of late Dinantian (Viséan) age; the last-named is the earliest known 'Amphibian' skeleton except the Ichthyostegids. The vertebræ of these earliest forms have large centra and small or absent intercentra, as in Microbrachids and Captorhinomorphs. Currently accepted views on vertebral evolution seem to require adjustment.

I suggest tentatively that the Ichthyostegids and Otocratia, which are quite distinct from the commoner Labyrinthodont groups, are early members of a group of primitive Tetrapods which gave rise to the typical Microsauria and to the Diadectomorph and Captorhinomorph reptiles. I hope to discuss the implications of these observations and suggestions elsewhere.

T. S. WESTOLL.

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[1] Westoll, T. S., NATURE, 149, 667 (1942).

[2] Watson, D. M. S., *Palaeont. Hungar.*, 1, 221 (1926).

[3] Säve-Söderbergh, G., *Medd. Grönland*, 94, Nr. 7 (1932).

Narcotic for Marine Invertebrates

THE following method is cheap and simple, and gives excellent results with such soft-bodied marine animals as have been tried (Polychætes, Doris, Priapulus, Nemertines, Ascidians). Make up 80 gm. of crystalline magnesium chloride in a litre of tap water. Immerse the animals in it. In one to four hours they will be relaxed and expanded. Add strong formalin to the magnesium solution; when they are dead, transfer to any desired fixative or preservative.

The solution is isotonic with sea-water, has apparently no irritating effects, and appears to be better and easier to use than menthol, cocaine, etc. In

Arenicola, at least, the tissues are undistorted and the material can be used for histological purposes.

The magnesium solution narcotizes but does not kill, at least for many hours. The narcosis can be rapidly reversed by transferring the animals back to sea-water.

ISABEL C. LEDINGHAM.
G. P. WELLS.

Department of Zoology,
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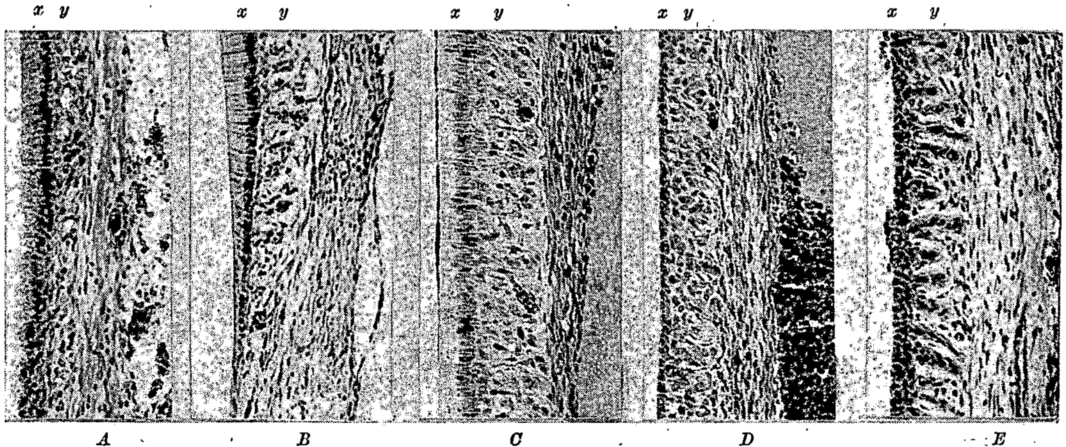
London.
June 24.

Enamel Organ of the Rat's Incisor Tooth in Vitamin E Deficiency

Davies and Moore[1] have pointed out that rats on a diet deficient in vitamins A and E suffered from a secondary vitamin A deficiency as evidenced by a disappearance of the vitamin from the liver; and also by a whitening of the incisor teeth, an effect which occurs in prolonged vitamin A deficiency[2] and was prevented by vitamin E dosage. Through the kindness of Dr. H. E. Brink, Department of Physiology, University of Stellenbosch, who has been working on vitamin E deficiency, I have been able to examine the incisor teeth of three female rats which had been on a vitamin E deficient diet[3] for 167 days from weaning. They had shown complete resorption of ambryos and the characteristic paralysis of the hind legs had just set in. The incisor teeth had the normal orange colour.



LONGITUDINAL SECTIONS OF THE MID-REGION OF THE ENAMEL ORGANS OF RAT'S TEETH.
In all sections the enamel has been lost during histological decalcification. *x*, ameloblasts, *y*, epithelial papillæ. (× 128)
A, *B*: Upper incisor teeth of two female rats 167 days on a diet deficient in vitamin E.
C, *D*: Two normal female rats 239 days old. *E*: Rat 150 days on a diet deficient in vitamin A.

Longitudinal sections of the upper incisor teeth were cut and stained with hæmatoxylin and eosin. On microscopical examination, an abnormal degeneration was found in the enamel organ, which is illustrated in the accompanying photomicrographs (*A*,*B*).

It should be pointed out that in the rat's incisor, the enamel organ, and especially the ameloblasts, regress as they get older, having an average life of 50 days[4]. In young rats with rapidly growing incisors, the ameloblasts are still columnar when they reach the gingival margin, since they take only 25 days to get there; but in adult rats, the incisor grows more slowly and the ameloblasts regress in the anterior third of the tooth. If the tooth grows faster than usual, as can be caused by cutting off the exposed part, then the accelerated growth causes the ameloblasts to remain columnar up to the gingival margin[5], and conversely, if growth is slowed, the ameloblasts regress earlier. The rest of the enamel organ also regresses in a manner comparable to that of the ameloblasts. The epithelial papillæ, which are very prominent in the middle third of the tooth, gradually shrink, but can still be seen in the anterior third of the enamel organ.

The incisor teeth of the three vitamin E deficient rats showed a premature and abnormal degeneration of the enamel organ. This was found in the centre of the middle third of the tooth. One rat showed a disappearance of the epithelial papillæ and a shrinkage of the ameloblasts to an ill-arranged cubical layer (*A*) and the other two rats showed a sudden disappearance of all layers of the enamel organ, which was replaced by fibrous tissue (*B*). Comparable sections of the same part of the enamel organ from two normal female rats are given in *C*, *D*. These rats were 239 days old. These sections illustrate the degree of variability found under normal conditions in this area. In *C*, the ameloblasts are still distinctly columnar, while in the other (*D*) they have regressed to a considerable extent. In both, however, the epithelial papillæ are quite large and pronounced. The diet deficient in vitamin E used by Dr. Brink was not deficient in vitamin A, and thus no whitening of the teeth was seen, though it is true that these rats were younger than those reported by Davies and Moore. That no deficiency of vitamin A occurred is seen from a comparison of *A*,*B*, the latter being from the corresponding part of the enamel organ of a rat 150 days on a diet[6] deficient in vitamin A. This shows the characteristic atrophy of the ameloblasts and also the shrinkage of the epithelial papillæ which are found in this condition and which are quite unlike the changes found in *A*,*B*.

It would thus appear that rats on a diet adequate in vitamin A but deficient in vitamin E developed an atrophy of the enamel organ of an unusual type, unlike that caused by any other vitamin deficiency and possibly specific to vitamin E deficiency. It is of interest that vitamin E deficiency, apart from producing a dental change from secondary A deficiency as reported by Davies and Moore, may also itself cause a degeneration of quite different kind in the same area.

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[1] Davies, A. W., and Moore, T., NATURE, 148, 794 (1941).

[2] Wolbach, S. B., and Howe, P. R., *Amer. J. Path.*, 9, 275 (1933); Smith, M. C., and Lantz, E. M., *J. Home Econ.*, 25, 411 (1933); Irving, J. T., and Richards, M. B., NATURE, 144, 908 (1939).

[3] Schoorl, P., *Arch. néer. Physiol.*, 19, 403 (1934).

[4] Schour, I., Hoffman, M. M., and Smith, M. C., *Amer. J. Path.*, 17, 529 (1941).

[5] Hoffman, M. M., Thesis, Univ. of Illinois. Quoted from ref. 4.

[6] Irving, J. T., and Richards, M. B., unpublished results.

Selective Excitation of Spectra by the High-Frequency Discharge

IN a series of preliminary investigations on the excitation of spectra by the high-frequency discharge, several interesting phenomena connected with intensity distribution have been observed, some of which have already been reported[1]. Further work indicates that these consist essentially in a redistribution of intensity among different band-systems of a diatomic molecule (that is, among different electronic energy levels) or among atomic energy states of different multiplicities. Thus the mercury spectrum observed shows that under certain well-defined and reproducible conditions, as for example pressure of gas, frequency of exciting oscillations, etc., only those lines are present which involve triplet initial states. Similarly, again under definite conditions, mainly those band systems of carbon monoxide are excited which involve only the singlet levels.

Keeping the pressure in the discharge tube constant, it is possible in the case of nitrogen, which has been studied so far, so to alter the relative intensities of the first positive and second positive band systems that either one or the other is more prominent at a given frequency of excitation. Thus it is found that with a gas pressure of about 7 mm. there is a critical value ($\sim$ 735 kc./sec.) for the frequency of oscillatory discharge, above which the second positive system and below which the first positive system gains in intensity. This is even more striking visually, the colour of the discharge undergoing a radical change when the frequency is altered.

The phenomena observed are different from those which involve a change of intensity distribution among various bands of a given electronic system. In the simplest case, such an effect will be a consequence of the interaction between the exciting particles and the vibrating nuclei, and has not been established so far in excitation by electrons[2]. In the presence of high-pressure argon[3], and in the afterglow spectrum[4], nitrogen exhibits such a change in distribution of intensity in its first positive band system, but obviously these involve different mechanisms.

The effects observed in the present series of investigations appear to be understandable from a consideration of the different excitation functions characteristic of the initial levels concerned. It has been possible to correlate all the facts with the form of the excitation function wherever this latter is known, thus making it possible to deduce the form of the excitation function in other cases where it may not have been known experimentally. The fact that this is at all possible, however, indicates that in the conditions under which the phenomena occur the following are true to a first approximation:

(1) The pressure in the discharge tube, the frequency of oscillatory discharge and the voltage across the electrodes determine, within a narrow range, the energy available for excitation.

(2) The main process of excitation involves only the emitters in the normal state; excitation through collisions of other kinds appears to be negligible.

Further work is in progress and details will be published elsewhere.

R. K. ASUNDI.
NAND LAL SINGH.

College of Science,
Benares Hindu University,
May 8.

[1] Asundi, Singh and Singh, *Proc. Ind. Sci. Cong.*, Part 3, 35 (1942); Asundi, Singh and Pant, *Proc. Ind. Sci. Cong.*, Part 3, 35 (1942).

[2] Langstroth, *Proc. Roy. Soc.*, A, 146, 177 (1934); also 150, 371 (1935). Hermann, *Ann. Phys.*, 25/2, 166 (1936).

[3] Johnson, *Phil. Mag.*, 48, 1069 (1924).

[4] Fowler and Strutt, *Proc. Roy. Soc.*, A, 85, 377 (1911).

The Problem of the Autonomy of Life

IN his letter published in NATURE of May 16, Prof. Donnan abandons his previous assertion that a potency for producing order resides in the temperature difference between two surfaces. He substitutes the obvious and indisputable statement that an energy disequilibrium is one of the necessary conditions for the production of the specific structure of a living organism. It is, of course, one of the necessary conditions for the production of anything, and so this does not get us any further. The cause of the discrimination of which there is evidence has still to be sought.

I am directing attention to this confusion between the *cause* of a phenomena, and the *conditions* which must pertain, so that the cause may become effective, because this is a very common confusion. It is at the bottom of many other attempts to explain the organic world. Among these is the attempt in Prof. Donnan's letter to do so by invoking photosynthesis. The problem, be it noted, is not merely why there may be in some cases, as Prof. Donnan puts it, "a decrease in entropy". The problem is far greater. It is to discover what in all living substance causes each particle to reach a specified position. *Why does the random incidence of photons lead to anything but a random arrangement of atoms?* The presence of enzymes and chlorophyll in living substance is (like the availability of energy) but one of the many conditions which must be met, so that the discriminating agent, whatever it be, may operate. To attribute discriminating powers to chemical substances would be medieval mysticism, so photosynthesis does not solve the problem. It is itself a part of the problem which we must seek to solve. The very presence of chlorophyll just in those places where it makes photosynthesis possible is another part of the problem.

If, as I have attempted to show, the source of the discrimination is not covered by even the widest definition of the word 'material', we certainly need, as Admiral Beadnell says, a new definition of 'non-material'. This definition must be neither so naive as to include things like electromagnetic radiation, nor so anthropomorphic as to identify non-material with mind. I am hoping that Admiral Beadnell may be among those who can accept my understanding of the term, though it would take too much space to explain it here.

Reginald O. Kapp.

University College,
London.

In my letter of May 16, to which Prof. Kapp refers, I tried to explain that the disequilibrium in question, involving as it does an increase of entropy, was a necessary (though, as I pointed out, not a sufficient) *condition* for the occurrence of the photochemical process, since the latter involves an increase of order and a decrease of entropy. I was careful to point out that the work of the biochemists and plant physiologists was necessary in order to complete the associated complex of conditions and processes which, together with the fundamental condition, constitutes a satisfactory causal analysis of the phenomenon. It will be obvious, I think, to those who have followed the discussion, that what Prof. Kapp now says constitutes a complete travesty of my remarks and demonstrates in the clearest manner that he has failed to understand their meaning.

I am glad, however, that Prof. Kapp has written this second letter, because readers of Nature can now see for themselves Prof. Kapp's method of conducting *his* type of "causal analysis". Let me give one or two examples. The molecules of glucose are found to build up the starch granules in the chloroplasts of a plant cell. Why is this? Because they follow the course *specified* for them. A chemical substance A, when presented in an organism with a mixture of substances B, C, D, etc., is found to combine with B, but not with C, D, etc. Reason for this? Very simple, an unknown X *discriminates*. And so on, *ad infinitum*. This sort of thing is not even "medieval mysticism"; the medieval philosophers and scientists, though suffering in general from a great paucity of facts, were after all good rationalists. Sound and sufficient experiments and sound and sufficient reasoning make science. One cannot buy (or sell) it with the currency of mere words; though you may run a dumb film on captions.

F. G. Donnan.

The Athenæum,
London.

General and Social Biology

The article by Mrs. S. Neville Rolfe in Nature of January 24, p. 90, calls for comment and support. Does it occur to the average man that, except at some schools, everything taught is factual, with definite conclusions? For example, history, geography, grammar, mathematics, physics and chemistry all produce definite results. But when we enter the world in which we live, we are emerging into a world of living and thinking beings. The facts can be ascertained, though often with much difficulty, but the conclusions are too often matters of probability.

It is true that contact with the world teaches some men the peculiarities of social life and human nature. But I cannot understand a nation without any universal training in social biology taking the sound road easily. Their minds have not been trained as they should be.

In administration the defect is obvious, and the difficulties in the way of problems of health are known to many people who have seen them in the Colonial empire. One item—and it is only one item—illustrates. During the War of 1914–18—and there I can speak from personal knowledge of the difficulties—in the British and Dominion troops there were 400,000 reported cases of venereal disease, and in the American Army 340,000, that is, 740,000 in all, with an average absence from duty of five–six weeks and causing a heavy burden on the services. Could this have happened if the military direction had grasped the situation before it developed? Much the same thing may be said of malaria, which took a heavy toll, although Field Marshal Allenby realized the danger and acted accordingly.

How many people realize that there are 650 million people suffering from malaria—about 1 in 3 of the population of the world. But the very good medical education in the universities is directed chiefly towards the treatment of disease. The prevention of disease and the maintenance of health, apart from disease, do not receive much attention. The social problems of housing, play space, town planning, etc., scarcely enter the medical curriculum.

Prevention means not only advice but also the active concurrence of everyone. But the general mass of the population, untrained in biology, will continue to make serious mistakes. All universities naturally divide their work into compartments, but the great problems of life very often do not fit into any compartment, and have to be attacked by other methods; hence the need for some form of sociological training.

James W. Barrett.

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Higher Algebra

My attention has been directed to an unfortunate error in my review of "The Tutorial Algebra" in Nature of July 11, p. 39. In fairness to the author especially, I should like to correct this. My query, "Is the condition . . . biquadratic?", should have referred to the converse, namely, Does the condition $ac-b^2>0$ hold for every biquadratic having at least two complex roots? My chief concern was to prevent the inference that the roots are all real when $ac-b^2$ is not positive; hence the example. I think the whole point would become quite clear if a brief note were added at the end of the proof of example (2) on p. 510 indicating (i) what happens when H is not positive or equal to zero, and (ii) whether the converse to the theorem proved is true, H being $ac-b^2$.

F. G. W. Brown.

Pyrethrum Sprays

In my article published in Nature of June 27 (p. 720) on "Biological Assay of Insecticidal Sprays", it was stated that a solution of pyrocatechol in ether was recommended as a stabilizer for the standard pyrethrum spray. It must be pointed out that this statement should apply only to a pyrethrum solution used as a standard for comparison in laboratory tests.

A solution of this type, in which ether is employed, would not be suitable for incorporation in a pyrethrum spray intended for commercial use, and the statement concerning its addition does not form part of the standard specification for this type of spray.

E. A. Parkin.

Pest Infestation Laboratory,
Slough, Bucks.

MINERAL AND VITAMIN REQUIREMENTS AND THE WAR-TIME DIETARY

At a discussion in the Section of Medicine of the Royal Society of Medicine on May 26 on mineral and vitamin requirements and the war-time dietary, some interesting and important points were brought out, though the subject is very wide and could therefore be covered only in part because in the vast limit it embraces both the qualitative as well as the quantitative requirements.

Mineral Requirements

Dr. R. A. McCance confined his attention mainly to calcium and iron, saying that sodium, potassium, magnesium, zinc and phosphorus and the 'trace elements' such as copper and manganese can be left to themselves. He opened by stating that to maintain ourselves in perfect health we have to *absorb* just as much calcium, phosphorus and other mineral elements as before the War; even then there was a belief that calcium and iron were deficient. In the modified and planned war diets, there is now plenty of milk for children but little for adults. The calcium and iron intake is maintained by the 85 per cent extraction loaf which has 2–3 times as much iron as in white bread. The problem is whether these two minerals are as well absorbed as in peace-time. In an investigation by Drs. McCance and Widdowson upon human subjects (taking more than fourteen months) the calcium proved to be less well absorbed when brown 92 per cent extraction flour was substituted for white flour in the diet. The same has been found more recently with iron, though the results need some repetition. The nature of the factor responsible for depression of absorption has emerged as the result of much research. E. Mellanby earlier stressed the presence of a rachitogenic factor in some cereals, especially oatmeal. Much later (1934) Bruce and Callow suggested that this might be inositol hexaphosphoric acid, a compound present in the outer parts of the cereal grains. In 1939 Harrison and Mellanby showed that addition of sodium phytate to puppies' diet led to rickets. It was left to McCance and colleagues to prove that the addition of sodium phytate to white bread depressed absorption of calcium and magnesium more than the brown bread diets, some subjects even excreting more calcium in the fæces than they took in the food (due to fixation of calcium in some of the intestinal secretion). Removal of phytin in bread is possible on the experimental scale though impracticable commercially, and does not completely reduce the error in absorption. Nor does vitamin D in physiological doses improve the absorption of calcium in adults. The cheapest and simplest way to counteract the action of the phytic acid is to add calcium as calcium carbonate to precipitate the phytic acid and so leave the remaining 'calcium' available for absorption. In the 85 per cent loaf this is about half the amount of phytic acid present in the '92 per cent'. Dr. McCance considers that the physiological arguments for addition of calcium (as calcium carbonate) to the 85 per cent loaf are very strong and that we should have the courage of our convictions and support the addition to maintain adequate calcium absorption. A similar argument holds for iron.

Prof, R. A. Peters in a short communication produced X-ray pictures by Dr. Kemp, of Oxford, to demonstrate that in a man of 52–53 years the addition of calcium carbonate to the maximum amount recommended by Dr. McCance and adopted by the Medical Research Council (namely, 14 oz. per 280 lb. flour) to 85 per cent extraction bread has produced no signs either of calculus or calcification of the femoral arteries. His family has lived on this bread (+ chalk) for thirteen months with no noticeable ill-effects, as indeed would be expected, when it is realized that the addition is only 1/20 oz. calcium carbonate in 1·3 lb. bread.

Dr. Murray Scott discussed minerals from a practitioner's point of view; as chairman of a local borough committee on bread, he has been trying to get evidence of deficiencies attributable to faulty diet, etc. In his part of the country medical and obstetrical opinion asserted there is increasing anæmia; examination of miners' wives showed reduction in hæmoglobin, and indicated that the miner frequently eats all the meat and cheese in the family ration. For several years second-year medical students at Leeds have estimated their own hæmoglobin; for the six years before the War the numerically largest group has always been in the 100–105 per cent hæmoglobin division. Last year, it was the 90–95 per cent division. A careful survey of prices in August 1941 showed that for an active man a complete optimum diet could not be purchased for less than 14*s*. a week, and for sedentary workers 11*s*. per week. Since the rationing of meat, bacon, eggs and cheese reduces the intake of iron to 1–2 oz. a day from this source, there is a theoretical expectation of increasing anæmia among the poorer half of the nation. The change to 85 per cent extraction meal will increase the iron of the diets for most people by about 2·5 mgm. a day, without disturbing the supply of calcium and phosphorus which comes from the milk, though the use of some of the wheatings in the new flour will deprive pigs and poultry of part of their present supply. In considering possible disadvantages of 85 per cent extraction flour, Dr. Scott was struck with the apparent discrepancy between the conclusions of Widdowson and McCance's experiments on iron and his general ideas, and wished to have evidence of lack of energy or fall in hæmoglobin. He instanced the case of two adults in his own household, who have eaten entirely wholemeal bread, and yet have hæmoglobins of more than 100 per cent. How does their iron escape the clutches of the phytic acid? In a speculative vein, he asked whether it is possible that prolonged eating of white bread led us to lose a capacity to deal with phytic acid (by phytases or otherwise) which was possessed by our ancestors. In conclusion, he expressed the view that diets contain less total iron than pre-war and that it is important to solve the question of how to increase the available iron in the nation's diet, preferably through bread.

In the parts of the subsequent discussion which bore upon minerals, Dr. H. M. Sinclair pressed for supplements of iron in the national dietary. Dr. A. P. Meiklejohn, in dealing with the question whether the addition of iron to bread was justified upon the evidence so far produced, stated that in a recent survey in Lancashire a random sample of young married women had (low) hæmoglobin limits of about 75 per cent (Haldane scale). Dr. Geoffrey Evans was impressed by the number of persons who had hæmoglobin values below 85 per cent and the obvious improvement by giving iron.

Prof. J. R. Marrack was a sceptic upon the possible 'de-mineralizing' effect of brown bread, as he has always eaten it and been able to play rugby football until he was forty-four. Dr. R. J. Atkins referred to the importance of trace elements and to the presence in soil of elements like manganese which interferes seriously with the absorption of iron. Mr. A. L. Bacharach said that in order to increase the general intake of iron by 5 mgm. per person a day, only eighty tons of iron salts would be needed, and that it was quite easy to carry this out with bread.

Dr. McCance, replying to several points, pointed out that the calcium requirement of individuals shows large variation; some would store calcium on a diet which would lead to loss of calcium in others. This probably explained Prof. Marrack's point. It makes the postulate of an absolute average requirement difficult, and indicates the need for playing for safety.

Summarizing this side of the discussion, there seems to be a general belief in the need for calcium and iron supplements in the diet, in some form, of which bread appears a reasonable medium.

Vitamin Requirements

The requirements of vitamins in the dietary were less thoroughly discussed, the main attention being given to vitamin C. Dr. L. J. Harris urged the existence of subclinical deficiencies. He directed attention to animal experiments in which it could be demonstrated that there is a grading of response to vitamin B_1 between the optimal dosage-level and one giving definite signs of deficiency. It is unlikely that this does not apply to man. He considers that his investigations have shown that levels of nutrition of some vitamins could be judged quantitatively by statistically controlled 'saturation tests' upon groups of people; this must not be taken to mean that he thinks that perfect nutrition is only co-existent with saturation. In the urinary saturation tests for vitamin C, the level of nutrition is judged by the speed with which the urinary excretion with test doses reaches on average a plateau; this takes only one or two days in subjects receiving proper amounts of the vitamin in their diet. Absence of scurvy does not mean necessarily having enough vitamin C. There occurs in man those symptoms of deficiency seen in guinea pigs, namely, diminished growth-rate, failure in the production of new tissues and increased liability to infection. He cited work from German official records in support of the view that extra vitamin C improves the annual gains in weights and height of children and diminishes the incidence of infections (1,600,000 children were given 50 mgm. vitamin C daily in addition to the ordinary war-time diet). In Britain, Glazebrook and Thomson have found less duration of tonsillitis and less disease in naval trainees dosed with vitamin C. Further, Crandon and associates in America and Hunt in Great Britain believe in the value of vitamin C in the healing of wounds; but it is true that the effect upon Crandon himself did not appear until a late stage in his vitamin C deficient diet. On the other side he quoted the view of Zilva (an authority on vitamin C) that even allowing for destruction in cooking, the war-time diet contains enough vitamin C, and also the observations of Fox and colleagues; the latter found that out of 950 miners getting 12–25 mgm. of ascorbic acid twelve developed scurvy, whereas only one out of a similar number getting an extra 40 mgm. developed scurvy.

This point was taken up by Dr. Sinclair, who thought that it created much difficulty in regard to subclinical deficiency, because there was no difference in incidence of infection in Fox's experiments. On the other hand, Dr. Meiklejohn said that long before Dr. Crandon showed signs of vitamin C deficiency he looked a sick man and suffered from vague symptoms of lassitude.

Dr. Harris also referred to the results of some of his saturation tests. Children at a good residentia institution showed consistently higher levels of excretion of vitamin C than those from poorer homes but during the War the level of both groups has fallen; this was more marked in the winter months and justified the decision to set aside supplies of vitamin C for young children.

In relation to this, Prof. Marrack said that in March and April he estimated ascorbic acid in a number of meals in school canteens and British Restaurants, where he found no evidence of excessive destruction in the preparation and cooking. The total ascorbic acid calculated as supplied for one third meals was less than 10 mgm. and for one third was more than 20 mgm. There was evidence that in saturation tests the number of boys saturating on the first day of giving the test dose increased with the average ascorbic acid content of the diet at the school. The highest saturation was in the school which grew abundant early green vegetables, and the choice of vegetables grown is important. It is unwise to trust to raw vegetables.

Dr. Atkins raised some critical points over the saturation tests. He found that in fifty men from the same kitchen differences of saturation occurred according to whether they had their vitamin C tablets before or after breakfast. Further, 40–100 left saturated ten months ago, showed no quicker saturation in a subsequent period of dosing than those previously unsaturated.

In conclusion of his remarks, Dr. Harris said 9 per cent of children in an institution, 15 per cent among urban children, and 18 per cent among village children could be improved by a vitamin A dosing, using a dark adaptation test (Yudkin). Six per cent of school children examined at Cambridge showed riboflavin deficiency (vascularization of the cornea by slit lamp examination). Dr. Geoffrey Evans from his own experience believes in the existence of deficiencies to-day, and stated that cases of acne rosacea with conjunctivitis and mild degrees of keratitis could be improved by giving riboflavin, and cases of fatigue and depression with vitamin B_1. Dr. Magee, striking a critical note, considered that not enough attention had been paid in the discussion to the quantitative requirements and pointed out the great differences between the standard for proteins and minerals which had been arrived at as the result of clear-cut experiments, and the vitamins. For these he regarded the evidence as still more approaching guess-work or speculation.

It is the opinion of the reviewer that the problem of actual quantities of vitamins required could well be discussed again, when more information is available. In regard to this vexed question of 'subclinical deficiency', it must be conceded that evidence is accumulating that levels of saturation of some vitamins may fall to a point which is dangerous in the sense that individuals may be too close to the point of actual deficiency. Such depletion periods will not matter so long as they are only biochemical, provided that they are reversed in time, because there may be still enough vitamin about to run essential biochemical processes. If, however, there is lso the ill-health suggested, it is important; but its ery vagueness must increase the need for caution and for prolonged experiments (taking into account all psychological factors) before coming to a final judgment. It is difficult to see how the state of the individual (as distinct from statistical averages over a group) can be assessed without combining blood estimations with clinical examinations, as Dr. Sinclair nd his colleagues are trying to do. So much for he purely scientific attitude. Meanwhile we are faced with practice in the War. We know from McCance and Widdowson that there is a wide difference in calcium requirements of individuals; we have he League of Nations standards for the earlier vitamin factors, but none for those more recently discovered; we know that even animals are individual in their needs of a vitamin like aneurin. Let us hope that ultimately we may be able to recognize on a scientific basis cases where intake of a special factor must be increased for an individual. For the moment we are left with the dilemma that diets must provide sufficient margin of accessory factors to ensure no physical nefficiency, and we must see that time and valuable foodstuffs (synthetic and natural) are not wasted; fortunately, the latter does not apply to chalk and iron.

R. A. PETERS.

AMINO ACID ANALYSIS AND THE STRUCTURE OF PROTEINS*

By PROF. A. C. CHIBNALL, F.R.S.

IN recent years X-ray crystallographers have made remarkable advances in the interpretation of protein structure, and it is becoming more and more evident that a stage has been reached when their views need to be reconciled with data obtained from accurate amino-acid analysis of the proteins concerned. In 1934 Astbury suggested that in gelatin the residues of glycine and hydroxyproline must repeat at regular intervals along the peptide chain, an idea developed in the following year by Bergmann and Niemann into a general hypothesis that (briefly) the 'frequency' of recurrence of any particular residue must be factorizable entirely by 2 and/or 3, as must also the total number of residues in the molecule. Evidence in its favour was adduced from analytical data for several proteins, including egg-albumin. The hypothesis has been criticized on various grounds, chief among them being that existing methods of analysis are in most cases not sufficiently quantitative to warrant the results being interpreted with the precision needed. What are believed to be quantitative estimations for the bases and dicarboxylic acids in edestin, egg-albumin and β-lactoglobulin have now been obtained.

Edestin.—The analytical data and calculated mean residue weight (115·7) show that the smallest possible unit contains 432 ($2^4 \times 3^3$) residues, and that the number of residues of arginine, histidine, lysine, tyrosine, tryptophan, methionine and cystine are 48, 8, 8, 12, 4, 8 and 3 respectively. On the assumption that the amide-nitrogen can be distributed in such a way that the number of residues of asparagine, aspartic acid, glutamine and glutamic acid are also factors of 432, it can be shown that these must be 27, 18, 36 and 36 respectively. The data lend support to the Bergmann and Niemann hypothesis, but at present there is no evidence that edestin is homogeneous.

β-Lactoglobulin is homogeneous. The analytical data suggest a molecular weight of 42,000, in agreement with physical measurement, but the total number of residues is not factorizable by 2 and/or 3. The Bergmann-Niemann hypothesis is thus not valid. On the assumption that the molecule is one peptide chain, the number of carboxyl groups computed from titration curves is in agreement with the chemical data, but the number of free amino groups is eight more than can be attributed to lysine. The molecule is a system of nine peptide chains, not all of like composition, coupled by linkages involving carboxyl and not amino groups. Imide and thiolester linkages are suggested; the presence of the latter would explain many puzzling features of denaturation.

Egg-albumin is not homogeneous and tells a somewhat similar story. Chemical data suggest a molecular weight of 43,000, in conformity with physical measurements; the Bergmann-Niemann hypothesis does not hold. From titration and other data it is suggested that the molecule is a system of at least four peptide chains having free terminal amino groups, recalling Astbury's deduction that the denatured protein is a pile of four laminæ.

Insulin.—If the excess of free amino groups is a measure of the number of peptide chains, as in lactoglobulin, the molecule of insulin must be a system of eighteen such chains, a striking confirmation of Bernal's prediction from the peaks in the Patterson projection.

Reverting to *edestin*, it has been found that the determination of free amino groups is complicated by edestan formation. It is probable that the submolecule of 50,000 is one peptide chain, though the possibility that it is a system of three peptide chains of unlike composition cannot be dismissed, in which case the allocation of the amide-nitrogen given above would not be justified. Nevertheless, the stoichiometric relationships exhibited by the other residues are sufficiently impressive to warrant the assumption that the constituent peptide chains would be built to essentially the same pattern based on $2^n \times 3^m$, though they might not contain the same number of residues. All other proteins may be similarly constituted. Such views emphasize the need for more work on the isolation and characterization of the partial decomposition products of protein, for much of the evidence hitherto brought forward to support the Bergmann-Niemann hypothesis has been based on inadequate experimental data and has demonstrated nothing more than the hypnotic power of numerology.

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* Substance of the Bakerian Lecture delivered before the Royal Society on July 16.

TIMBER-SEASONING KILNS

TWO leaflets have recently been issued by the Forest Research Institute, Dehra Dun, India, on the subject of timber seasoning kilns by M. A. Rehman, Utilization Branch (For. Res. Inst. Public. Vasant Press, Dehra Dun, 1941–42). Leaflet No. 11, "Types of Timber Seasoning Kilns suitable for drying Indian Woods" (1942), describes briefly the various types of seasoning kilns which have been designed or tested by the Forest Institute. It was due to the position in which we found ourselves during the last War in the matter of timber supplies, especially perhaps in the demand for, and absence of, seasoned timber for the increasing aeroplane construction, that led to the first marked improvements in artificial kiln seasoning. Experiments and research in this direction were taken up at the Institute in the early years after the War, and this small leaflet gives briefly some of the results which have been reached —results which are at least as important economically as in temperate zones. The general principles of the steam-heated internal-fan kiln and four types of furnace kilns are discussed, the direct-heated forced-circulation furnace kiln, the indirect-heated internal-fan furnace kiln, the new F.R.I. furnace kiln and the hot air kiln. The results of tests show that a steam-heated internal-fan kiln is suitable for the seasoning of almost all kinds of woods. Of the furnace kilns, the first mentioned above is suitable for drying furniture woods, the second for drying packing-case timbers only, the third for the slow seasoning of furniture woods and the fourth for completing the drying of partially air-seasoned half-wroughts for the manufacture of certain types of articles. The third of these furnace kilns is cheaply manufactured, was designed at the Research Institute and is termed the indirect-heated thermal-circulation furnace kiln.

The fourth furnace kiln, the hot air kiln, briefly alluded to here, is discussed in detail in Leaflet No. 5, issued by the Research Institute in 1941. It is common knowledge that air-seasoning of timber is slow but yields eminently satisfactory results, well known to previous generations. In these hurrying days of greater demand, assisted by two major wars, the periods required to produce air-seasoned material of the various species of timbers are too long. As an example, 1-inch planks of hardwoods suitable for furniture manufacture take at least three to four months to become properly air-seasoned, and larger-sized timber correspondingly longer. The kiln considerably reduces the period. For example, it is estimated that 2½ in. × 2½ in.-blanks of refractory hardwoods cut from planks which have been air-seasoned for about two months can be completely seasoned in about fifteen days in a hot air kiln of this type. This kiln is a masonry chamber provided with a number of ducts in the floor through which hot gases from a wood-burning furnace are passed. The chamber is fitted with racks for holding the half-wroughts of wood to be seasoned. These consist of shuttles, bobbins, picker arms, helves and tool handles.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Friday and Saturday, July 24-25

BRITISH ASSOCIATION (DIVISION FOR THE SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10 a.m.—Conference on "Mineral Resources and the Atlantic Charter", to be opened by Sir Richard Gregory, Bart., F.R.S.*

Friday Morning Session

Chairman: Sir Thomas Holland, K.C.S.I., F.R.S.; Speakers: Prof. H. H. Read, F.R.S., Prof. P. G. H. Boswell, F.R.S., and Prof. C. B. Fawcett.

Friday Afternoon Session

Chairman: Sir William Larke; Speakers: Prof. W. R. Jones, Sir Lewis Fermor, F.R.S., Lt.-Col. the Hon. Colin A. Campbell.

Saturday Morning Session

Chairman: Dr. C. H. Desch, F.R.S.; Speakers: Dr. E. F. Armstrong, F.R.S., Dr. W. H. Hatfield, F.R.S., Dr. David Williams, and Sir Harold Hartley, F.R.S.

Saturday Afternoon Session

Chairman: Sir Stafford Cripps, P.C.; Speakers: Prof. J. G. Smith, Dr. W. A. Lewis, Dr. E. P. Penrose, Mr. A. Notman, Dr. O. W. Roskill, and Dr. L. Dudley Stamp.

Tickets from the Secretary, British Association, Burlington House, Piccadilly, London, W.1.

Saturday and Sunday, August 1-2

ASSOCIATION OF SCIENTIFIC WORKERS (IN COLLABORATION WITH T FEDERATION OF AYRSHIRE SCIENTIFIC FILM SOCIETIES) (at Ayr). Conference on "The Scientific Film and Scientific Film Societies".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on before the dates mentioned:

VETERINARY INVESTIGATION OFFICER—The Secretary, West Scotland Agricultural College, 6 Blythswood Square, Glasgow (July 3

LECTURER in MATHEMATICS in the Technical College, Cardiff—T Director of Education, City Hall, Cardiff (July 31).

GRADUATE IN ENGINEERING TO TEACH TECHNICAL SUBJECTS A ALSO TO ACT AS ORGANIZER OF THE TECHNICAL CLASSES in the Basin stoke Queen Mary's School and Technical Evening School—T County Education Officer, The Castle, Winchester (endorsed 'Basin stoke') (July 31).

TWO DEMONSTRATORS (MALE OR FEMALE) IN ANATOMY—The Regi trar, The University, Sheffield (July 31).

LECTURER IN THE DEPARTMENT OF CHEMISTRY—The Registr University College, Southampton (August 4).

LECTURER IN MECHANICAL ENGINEERING in the Cannock Cha Mining College—The Director of Education, County Educati Offices, Stafford (August 7).

HEAD OF THE ENGINEERING DEPARTMENT at the County Technic College, Wednesbury, and COUNTY LECTURER IN ENGINEERING f South Staffordshire—The Director of Education, County Educati Offices, Stafford (August 7).

LECTURER FOR EVENING CLASSES IN CHEMISTRY—The Princip Technical College, Kingston-upon-Thames, Surrey.

GRADUATE IN ENGINEERING, and a GRADUATE FOR GENER SCIENCE AND MATHEMATICS, at the Eastbourne Technical School—T Education Officer, Education Offices, Eastbourne.

CHEMIST OR CHEMICAL ENGINEER WITH EXPERIENCE OF RUNNIN AMMONIA SODA PLANTS and with knowledge of the heavy chemic industry, for India—The Secretary, Overseas Manpower Committ (Reference 338), Ministry of Labour and National Service, Hanwa House, Red Lion Square, London, W.C.1.

TWO DEMONSTRATORS IN PHYSIOLOGY—The Professor of Physiolog The University, Liverpool.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Polish Science and Learning. Edited for the Association of Polis University Professors and Lecturers in Great Britain. No. 1, Jun Pp. 68. (London: Oxford University Press.) 2*s*. 6*d*. [8

Geological Survey of Great Britain: England and Wales. Wartim Pamphlet No. 25: The Geology of the Warwickshire Coalfield in Ne Series One-inch Sheets 154–5, 168–9, 184. By Dr. G. H. Mitchell with Animal Palæontology, by Dr. C. J. Stubblefield, and Pla Palæontology, by Dr. R. Crookall. Pp. 40. (London: Geologic Survey and Museum.) 1*s*. 10*d*. [9

Annual Report of Gresham's School Natural History Society, 1942 Pp. ii+18. (Holt: Gresham's School.) [13

Annual Report of the Council of the Yorkshire Philosophical Societ for the Year 1941. Pp. 24. (York: Yorkshire Museum.) [13

Ollsgoil na h-Éireann: the National University of Ireland. Calenda for the Year 1941. Pp. x+268+418+52. (Dublin: National University of Ireland.) [13

Other Countries

Flora of Fukien and Floristic Notes on Southeastern China. B Prof. Franklin P. Metcalf. Fascicle 1. Pp. xvii+82. (Canton Lingnan University.) [8

Forest Bulletin No. 100 (Utilisation, New Series): Wrapping an Packing Papers from Ulla Grass (*Themeda arundinacea*, Ridley, Si *Anthistiria gigantea* Cav.). By M. P. Bhargava and Chattar Singh Pp. iii+13. (Delhi: Manager of Publications.) 6 annas; 7*d*. [8

Sudan Government: Wellcome Chemical Laboratories, Suda Medical Service. Report of the Government Analyst for the Yea 1941. Pp. 19. (Khartoum: Wellcome Chemical Laboratories.) [9

Proceedings of the United States National Museum. Vol. 92, No 3136: A New Species of Phyllopod Crustacean from the Southweste Short-Grass Prairies. By J. G. Mackin. Pp. 33–39. (Washington, D.C.: Government Printing Office.) [10

Smithsonian Miscellaneous Collections. Vol. 101, No. 14: Tw New Fossil Birds from the Oligocene of South Dakota. By Alexande Wetmore. (Publication 3680.) Pp. ii+6. (Washington, D.C.: Smithsonian Institution.) [10

Smithsonian Miscellaneous Collections. Vol. 101, No. 15: Fift Contribution to Nomenclature of Cambrian Fossils. By Charles E Resser. (Publication 3682.) Pp. ii+58. (Washington, D.C.: Smith sonian Institution.) [13

Catalogues

Wild-Barfield Heat-Treatment Journal. Vol. 4, No. 32–33. Pp 71–78. (Watford: Wild-Barfield Electric Furnaces, Ltd.)

A Catalogue of Books on Entomology and General Natural History (No. 600.) Pp. 28. A List of Selected New and Recent Publications (New Book List No. 15.) Pp. 6. (London: Bernard Quaritch, Ltd

General Catalogue. (Catalogue No. 661.) Pp. 86. (London: Franci Edwards, Ltd.)

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SOCIAL MEDICINE

THE announcement that the Nuffield Provincial Hospitals Trust is prepared to endow for ten years the creation of a professorship of social medicine in the University of Oxford has created various favourable comments in the general Press. It is one of the signs of the times, which all indicate that the social aspect of medicine is coming inevitably to the fore as the public realization and appreciation of its importance increases.

The War has expedited the change in public opinion indicated by the proposal, but the course of things has been long proceeding. The Elizabethan conformation of the Poor Law meant that no one need starve or lack medical aid in England. It took long centuries to realize the extent of the obligation this imposed, and only recently has its full value been appreciated, behind which is the philosophy of social consciousness which has become more and more sensitive as the decades have succeeded one another. Gradually, voluntary and official hospital provision has grown, including that of special hospitals for particular complaints, and the habit has been created—indeed it is a necessity—of hospital treatment of major diseases. Not only this, the growth of 'specialism' and consequent extension of medical work implied has necessitated special provision, and few people can now deny that they are better treated in these hospitals than in private practice.

The trend is always increasing, and this must of necessity go on, because the standard of effort advancing medical science is always improving. It is to meet this increasing standard of medical attendance that the Nuffield professorship in social medicine now created is especially directed ; it will also have an indirect value in preventing disease, or what in many instances is tantamount to that, in treating it before it reaches an incurable stage. There is by no means enough liaison between the general medical practice of to-day and preventive medicine. Such universal problems as motherhood, childhood and youth, tuberculosis, cancer, venereal diseases should not be left to medical individuals or groups of individuals. Much has been and is being done by various groups (often in collaboration with the Ministry of Health) ; but it is not enough, because only a minor percentage of the population is reached by such methods. Whether the State should take over responsibility is a moot point ; for the grave risk of compulsion is here implied. Compulsory inoculation or treatment for various types of disease might, on casual consideration, seem the easiest way out ; but various inquiries concerning its effects in countries where it exists show that disturbing consequences often arise. In a democracy such as ours, enlightenment and education, especially in healthy living and in medicine as a social science, are clearly the best solutions to a problem of ever-increasing complexity.

This process, which has been increasing in emphasis decade by decade, has been expedited by the War, and many medical practitioners now in military service are unwilling to go back to the hampered conditions of ordinary single-man medical work. Medicine is clearly developing as a social science and team work is increasing, thus casting off its fetters as a closed profession. As Sir Arthur Newsholme has pointed out*, "in future practice, blundering experiment and erroneous procedures can best be avoided when one knows what others have done and what has been the outcome of their practice".

The procedure of medical insurance is evidence of this process. Already a third of the working-classes, including many black-coated workers, are within the national scheme ; and there is concurrence of evidence from the British Medical Association, representing the great mass of the practitioners in Great Britain, of testimony to the fact that this process should be extended to the dependants of insured persons. This would mean that four fifths of the population of the country would be removed from the evils of cash nexus which at present fetters medical work. It is not difficult to see the future course of events. Ere long, under the pressure of the medical profession, all workers will have to be provided for by a national system of medical service. Whether the expenditure incurred will come solely out of rates and taxes, or whether a system of payment by weekly stamps in which all have partnership—employers as well as employed—and in which the State sees that equitable provision is made, is still disputable ; but there can be no doubt as to the trend of events in this connexion. Everyone is interested in the maintenance of health ; family health and industrial health are merely aspects of the same problem, and everyone is concerned at the present lack of continuity in such medical assistance as is forthcoming. The financial aspects alone of this discontinuity are serious. While not advocating any undue increase in consultant, pathological and X-ray aids to medical practice, their lack is often felt deeply by the general practitioner to the detriment of the patient. In particular, the fastidious general practitioner often leaves off attending his patient when in more favourable circumstances he would like to continue to watch him. This consequence of discontinuous medical care is to the detriment of both medical man and patient.

For this state of things the growth of medical science is largely responsible. It is no one's fault, but the present condition of things is becoming intolerable, and there is an increasing call for the availability of expert medical help to the full extent needed.

It has been increasingly clear that there is need for a closer unification of local and national medical services, and few will doubt that such unification should not be left to medical men, but should be organized by the public authorities in consultation with the former. This will be one of the urgent immediate problems in medicine viewed as a social science.

The Nuffield Trust endowment for this and other purposes will facilitate matters. One may rightly wish God-speed to its efforts, and special success to the new professor of social medicine.

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* Medicine and the State. By Sir Arthur Newsholme. (London: George Allen and Unwin, Ltd., 1932.) 7*s*. 6*d*. net.

SCIENCE AND RELIGION

The Human Meaning of Science

By Arthur H. Compton. (John Calvin McNair Lectures.) Pp. xiv+88. (Chapel Hill, N.C.: University of North Carolina Press ; London : Oxford University Press, 1940.) 6*s*.

THIS is a small book on a very large subject, and it would be unreasonable to expect any comprehensive or fundamental discussion in three lectures. What the author gives us is interesting enough, though the reader must often find himself asking questions which in these pages at least have no answer. The second lecture, which is on the subject of human freedom and physical law, is a lucid and valuable statement of an argument for freedom. Dr. Compton does not allege that modern developments of physics can be used as an argument to establish the reality of freedom, but he does hold, and surely with good ground, that the argument in favour of determinism which was based on the alleged universality of natural law no longer possesses its ancient cogency. The newer quantum mechanics are "consistent with the postulate of freedom". There is no discussion of the meaning of freedom, but it appears to be identified with the "effectiveness of purpose" as in the following sentence: "My experience of the effectiveness of purpose is more direct and cogent than any logical argument based upon scientific generalizations".

The first lecture in the book is on "Science, Religion and Human Growth", and it must be confessed that to one reader at least it has seemed to err on the side of optimism. We are taken rapidly through the obvious advantages which science has conferred on the human race, and stress is laid on the mental and spiritual gifts of science. We have been taught "the importance of reliable knowledge". We have "gained confidence in our strength" and have therefore a more hopeful outlook on the future than our unscientific ancestors. One cannot help wondering whether these statements are accurate. It may be that we understand the importance of reliable knowledge, but the fact is that there never was a period when men were more easily swayed by propaganda, which is usually the dissemination of unreliable knowledge, nor does a contemplation of the possibilities of scientific warfare conduce in all minds to a hopeful view of the prospects for civilization.

There is, however, one consequence of scientific civilization as defined by Dr. Compton about which his language is ambiguous. "It would seem to be a corollory of the growing complexity of civilization that people must give more and more attention to the rights of others." The word "must" is notoriously misleading, and it is not clear whether the author means that science and technology produce altruism or whether the progress of science and technology ought to be accompanied by a growth of conscience. On the whole, Dr. Compton seems to believe that law and justice not only ought to prevail but necessarily will prevail. We may at least agree that unless co-operation is achieved and placed upon firm foundations, the conditions that make advance in science possible will eventually disappear. No doubt this would be most deplorable, but it is not evident that it could not happen.

The third lecture, on "The Need for God in an Age of Science", would require a long discussion to do justice to its argument. The thesis is that "the hypothesis of an intelligent God gives a more reasonable interpretation of the world than any other", and the chief emphasis is laid upon the evidence of "direction" or of intelligence in evolution. "Evolution is in itself no explanation of these remarkable processes; the theory of evolution is merely the description of how the processes occur. It is, however, difficult to avoid an interpretation which sees underlying these evolutionary processes an intelligent power, directing them with some great purpose." I have, naturally, no quarrel with this conclusion, but I am moved once again by reading this stimulating little book to wish that I knew precisely what was meant by the "theory of evolution".

W. R. MATTHEWS.

THE OLD AND THE NEW IN INDIA

Ethical Ideals in India To-day

Conway Memorial Lecture delivered at Conway Hall, Red Lion Square, W.C.1, on March 22, 1942. By Dr. Edward Thompson. Pp. vi+39. (London: Watts and Co., Ltd., 1942.) Cloth, 2*s.* net; paper, 1*s.* net.

THERE is a certain appropriateness in contemplating the development of ethical ideas in contemporary India; for there are few countries, Russia and China excluded, where the march of history has engendered such violent conflicts in the mental and moral attitudes of peoples as in Hindustan. Dr. Edward Thompson, who has devoted many years of service to India, did well, therefore, in choosing this theme for his Conway Memorial lecture this year.

The main thing about recent ethical ideas in India, which emerges from Dr. Thompson's exposition, is that they are much more intimately allied to the modern political movement than ethical ideas have been in Europe. So that they would seem, at first sight, to be in the main tradition of Indian thought, which looks at man as a whole, and in which man's philosophical, ethical, æsthetic and political ideas have been regarded as all part and parcel of each other. Yet, these contemporary ethical ideas in India, being more intimately associated with the individual great men of whom Dr. Thompson speaks in his lecture than with schools of thought and religion, partake of the character of the modern European, individualist sense of values.

This peculiarity is implicit in the workings of India's recent history. The feudal structure of society broke down in India in the last hundred years. The old self-governing, self-sufficient village system was smashed and the locomotive connected the most obscure corners of the land to the town, the seaport and the world market. "Telegrams and anger" came into India and the "steel frame" of a central government introduced a political and economic system which changed the very fabric of old social relations. The capricious and fluctuating prices of grain in the exchanges of the world destroyed the uncanny, unknown 'fate', symbolized in the all-powerful Nature, and substituted a new unseen fate, the stockbroker. All the ancient cultural traditions, though surviving as quasi-feudal forms in the very midst of this modernity, began to corrode from within.

In such an India, in the midst of these anachronisms, the difficulties of regeneration having been increased by the frustrations of political advance, the very best minds of India struggled to adapt themselves and their country to the outside world, which itself was changing fast. The shocks upon their sensibilities were acute and so were their reactions.

From Ram Mohan Roy, the first great modern Indian who believed in the truth of the unity of all mankind, to Jawaharlal Nehru, a believer in international socialism, there have been many vital and original responses to the complex questions of our age. Dr. Thompson chooses for special attention the answers of three significant men: Gandhi, Tagore and Iqbal. All three, ranking high among world thinkers, are shown to be oscillating between the old and the new in contemporary India, torn almost like that great Englishman whom Shakespeare pictured as the Prince of Denmark.

What exactly was the problem they posed before themselves, and how did they seek to solve it? I have already referred to the great social upheaval, the overturning that happened in India after the coming of the British. That was the atmosphere in which these three men grew up, and, inevitably, they asked themselves to what extent they could actively help or hinder this overturning, and what was the ethics of behaviour called forth from them.

Gandhi read Ruskin's "Unto This Last". Perhaps he also heard "the shrill cry that goes up from the factory chimneys, fiercer than the furnace blasts". Anyhow, he determined to change his life in the light of that book, or rather in the light of the three principles he deduced from it: (1) the good of the individual is contained in the good of all; (2) the dignity of labour; (3) the life of the tiller of the soil and handicraftsman is to be preferred to all. After serving in an ambulance unit in the Boer War, he added to this the belief in *Brahmcharya*, or sexual continence. Further, since he had become aware of the restrictions placed on Indians by the South African Government, he elaborated a further doctrine called *Satyagraha*, or soul-force, with which he sought to struggle against authority, the actual method being the old Indian practice of *Dharna*, the aggrieved sitting at the doorstep of the oppresser until his grievances were remedied. This 'stay-put' strike, backed by soul-force or truth-force, later known as civil disobedience, was to be characterized by a strict *ahimsa*, which Gandhi translated as non-violence, and which has become familiar in our time through its adoption in the mass campaigns of the Indian National Congress in its struggle for freedom.

Dr. Thompson's exposition of Tagore's ethical beliefs is also an implied criticism of Gandhi's doctrine. For Tagore, though aware of the enormous gains achieved by non-violence, considered it to be ethically an inadequate doctrine. "I believe," he wrote in an open letter to Gandhi, "in the efficacy of *ahimsa* as the means of overcoming the congregated might of physical force on which the political power in all countries mainly rests. But like every other moral principle, *ahimsa* has to spring from the depth of mind, and it must not be forced upon man from some outside appeal of urgent need. . . . When it concerns an immense multitude of men of different traditions and stages of culture, and when the object for which such repression is exercised needs a prolonged period of struggle, complex in character, I cannot think it possible of attainment."

Tagore himself, "choked for breath in the hideous nightmare of our present time", tried to be an individual and to teach others to be individuals in his school at Shantiniketan. He regarded with contempt the 'mendicancy' of Gandhi's method and held the more positive belief that "weakness is sinful, because it is a menace to the strong and the surest cause of downfall for others than those who own it." This individualism, which owed a great deal to the West, alternated with many, even anthropomorphic, moods in him before it reached a kind of scientific humanism towards the end of his life. Then Tagore was inclined to believe in a new morality of the poor such as may arise from a change in the *status quo*, as a reaction against the prevalent morality in which the rich can steal millions but the poor are imprisoned for stealing a loaf of bread, a morality which, he believed, was extraneous to society and had lost touch with it.

The approach of the North Indian poet, Muhammad Iqbal, shares the positive urge of Tagore, though, being more concerned to re-interpret Islamic thought in order to supply the lacunæ in the theoretical background of modern Muhammadan communities, he found himself adopting the old ethics of the Koran. Nothing less would do than the formation of a holy kingdom, *Pakistan*, somewhere in the north of India, where the old brotherhood of Islam would be revived. This brotherhood would not be liberal, nor based on the recognition of human or ethical equality of men, but on the strong individual re-orientating, or rather stretching, the old gospel to admit of modern scientific ideas such as evolution, God as time, the final judgment day as an alternation of day and night when good deeds bring their own reward, as in the Hindu doctrine of *Karma*.

Except for Tagore and Nehru, both imbued with the atmosphere of our age and straining for a new morality, the great leaders of Indian thought fail in the final analysis and yield to the past. Rising on the crest of an emancipatory movement, the children of a great overturning in Indian history, they resent further change. The resistance to the machine in Gandhi's ethics is reminiscent not only of Ruskin but also of the illustrious Tolstoy, the man who greeted the abolition of serfdom only to cry halt in front of the English industrial revolution.

Why does this peaceful Yasanya Polyana ethic reappear in more or less the same form at the ashrams of Sabramati and Wardha ? Dr. Thompson has a brilliant flash of insight into such recurrences when he compares Gandhi's recommendation of non-violence to the Abyssinians against Mussolini, with Chamberlain's appeasement of Hitler. In fact, the whole lecture shows an uncannily sympathetic grasp of the Indian attitudes in their interconnexion with world modes of thought. I have not the space to bring out the significance of all the attitudes Dr. Thompson treats of, but I may answer the question I have just raised.

It is possible that non-violence springs from a feeling of weakness in the face of the tiger; it is conceivable that it owes a great deal to the lack of cohesion in the forces behind one; but it is certain that it springs from an almost unconscious acquiescence to those who seek to preserve the past, even in putrescent decay, and who dread another over turning. Because non-violence in India implies active moral resistance, it is certainly more positive than appeasement, but any dynamism it has is due to its organized application in mass campaigns rather than to the individual who conceived it, however high the ethical merit of the conception—the proof of the pudding, like that of any other, is in the eating. We shall see how non-violence fares in its application against the marauding hordes of Nippon now ranged on India's frontiers, if the Government still ties India's hands and if Gandhi still insists on applying it. MULK RAJ ANAND.

PAST, PRESENT AND FUTURE OF AVIATION

Air Power and Civilization

By M. J. Bernard Davy. Pp. viii+202+8 plates. (London: George Allen and Unwin, Ltd., 1941.) 8*s*. 6*d*. net.

MR. DAVY'S book merits the attention of many people, for it is comprehensive. Those who are interested in the days previous to the invention of flight will find some very interesting chapters going back to the ideas of Leonardo da Vinci and tracing the subject through the great balloons of Montgolfier to the advent of the aeroplane. Then Mr. Davy deals with the historical production of flight, and here nobody has greater authority. I myself am very critical of the contributions by different people which have been very much mixed up lately with fallacious claims. Mr. Davy, with his knowledge and study of these early times, brought about no doubt by his association with the aeronautical exhibit in the Science Museum, gets everything right, so that I look upon his early historical side as something well worth preserving and referring to, should reference back be sought on any point.

The book then passes to the power of the aeroplane, describing with great interest the first aerial attack and the use of the aeroplane as a lethal weapon, culminating in the present situation, and then it deals with the future. It will be seen, therefore, that there is little in aviation, approached in a general way, that Mr. Davy does not deal with; and for that reason his book must command the respect and attention of all students of this great problem.

Mr. Davy does not think that internationalization of air is the complete solution, or that it could be feasible. I cannot agree entirely with this. I think so much depends on at what time it is done. It could be done now, but if it is put off until it is too late it will never be done, and the continuance of subsidized air lines as cover for air forces will start again. Mr. Davy thinks that regional air police forces might be a beginning, eventually coming all together in a world federation. It is a matter of how much we can do. No one will dispute that a world federation of the air is imperative. Whether it can be done all at one time, or whether the idea of regional air police forces does not lend itself to further conflict, is for the reader to decide. But here is an attempt to deal with this great question of air control after the War, and the more people are conversant with the ideals and the difficulties the sooner we may reach some solution of this difficult problem.

Mr. Davy does not direct attention to what, I think, is rather a curious situation in flight. There are many things we use to-day which were not possible for man to have created—say two or three hundred years ago—because the technique in manufacture was not available to him. For example, the motor-car could never have been built for the Romans; they had neither lathes, the metallurgical knowledge, nor the engineering ability. But look to-day at a modern high-efficiency glider—a glider with a rate of fall of 1 in 20; there is nothing in it that could not have been built a thousand years ago with ease. So that although actual power flight waited on the internal combustion engine, had gliding been indulged in seriously and the basic principles of gliding flight appreciated, we could indeed, a thousand years ago and more, have had controlled gliding flight with its very vast potentialities already available to mankind before the advent of a power unit. In fact, I think, gliding flight is one of those things which came very much later in history than was possible.

Mr. Davy says that Nature did not provide any devised pattern for man to copy, but I think for gliding flight with those very high aspect ratio birds such as the gull, there was indeed a pattern to be copied, and although propulsion by the flap wing introduced very grave mechanical difficulties, yet the gull is so lazy and uses air currents with such efficiency that it did not require very great intelligence to realize that the trouble could have partially been got over by using rising currents of air apart from propulsion. Even to-day we have a lot to learn from Nature, especially in noticing that maximum power in the bird is used not only for getting off, but in landing, whereas all our aeroplanes land on the straight dead glide—a system which is not utilized in Nature except occasionally on the water. Usually tremendous power is exerted to stop forward movement and give lift just before contact with the ground. Something along these lines is badly wanted to-day, as all aircraft are in the greatest danger when landing.

Due tribute is paid to Caley, Henson and Stringfellow, which they well deserve. Stringfellow, I see, gave performances of a model in Cremorne Gardens in 1848. This remarkable seat of aviation and entertainment, now filled by Lot's Road power station, must have been a very attractive rendezvous. Some of the first ascents by balloon were made from these Gardens.

The work of Pilcher has not been given enough attention in the book. He was not only a follower of Lilienthal in gliding, but he himself also invented some very remarkable devices. For example, he was towed up into the air as a kite by a system of tackle, gearing himself up and being pulled by a horse. Along these lines he did exactly what is to-day done by a motor-car pulling a glider up as a kite to start with before it glides. Lilienthal never did that, always relying on downward flight in a rising column of air on the surface of a hill.

I do not think the Wrights' patent is put in the clearest way. This patent was the claim that the warping of the wing or the aileron did not restore lateral stability and that if you wished to restore it, it was not only necessary to put the extra angle on the wing, but it was also necessary to interconnect this with rudder action of a reverse type. Otherwise the extra drag due to the increased angle of the wing rendered nugatory the potential extra lifting power. Mr. Davy deals with the Wright-Langley dispute in a very interesting part of his book. It was a situation which is little appreciated in Great Britain.

In the early heroic epoch of flight in Europe, not enough tribute is paid to the first Gnome engine, which was a revolutionary design. It was self-cooling by the rotation of the cylinders, and for its day was extremely reliable. Another interesting point is that due to the exhaust valve in the top of the cylinder, the engine consumed more lubricating oil than petrol, and it was not until somebody remembered the extraordinary properties of castor oil, which becomes stickier the hotter it gets, that this engine became a practical proposition. This engine did more to help along European aviation than any other factor.

I have told the story before of how on behalf of the Aero Club I went on a deputation to the War Office offering to lend two machines for the manœuvres and was rebuffed by them saying that they did not see any uses for aircraft in war. I always consider this a very remarkable episode in my life, but Davy quotes an equally remarkable incident, which is that "in 1907 the Wright brothers corresponded with the First Lord of the Admiralty concerning their invention, and they were informed by him that, after consulting expert advisers, the Board of Admiralty 'were of opinion that they [aeroplanes] would not be of any practical use to the Naval Service' ". It sounds amusing now, but the suspicion rather creeps into one's mind as to whether the same thing is not being done to-day relative to new inventions.

I am glad the bombing of Rotterdam on May 14, 1940, is brought into the book, because here I think is one of the most dastardly air attacks that was ever made or ever will be made. Fifty thousand casualties, including thirty thousand dead, against the unoffending Dutch is a blot upon the *Luftwaffe* that can never be extinguished.

I am pleased to find that Mr. Davy accentuates the point that real progress on beneficial lines will not really occur if the design and manufacture of aeroplanes is to be determined by the requirements of naval and military air forces. That has been one of the reasons more than any other that progress has not been made along real civilizing lines. There is much to be done—assisted take-off, high wing loading, non-inflammable fuel, better landings, pressurized cabins, jet propulsion; these are all problems of the future which will be great contributions towards flying as a safe and prosperous form of transportation.

Mr. Davy deserves great credit for his book. Not only will the reading of it convey immense knowledge of a subject which from the practical point of view is only some thirty years old, but also it must leave in the minds of all readers food for contemplation and thought as to the future. If I have any criticism, it is that the illustrations might have been better selected, but I am glad to see included the historical picture of the first flight on December 17, 1903.

BRABAZON OF TARA.

LEUKÆMIA IN ANIMALS

Spontaneous and Experimental Leukæmia in Animals

By Dr. Julius Engelbreth-Holm. Pp. xxiii+245+24 plates. (Edinburgh and London: Oliver and Boyd, 1942.) 15*s*. net.

LEUKÆMIA, though a relatively rare disease, has many appeals. The clinician is confronted with a progressive and mysterious increase in the white cells of the blood and blood-forming tissues, resulting, unhappily, in the loss of young life. For the hæmatologist, the chief problem is the origin of these blood cells; the specialist in cancer research is concerned since there are many features in common between leukæmia and malignant tumours. The student of comparative disease, the virus investigator and the geneticist find fascinating problems, while the theoretical pathologist may well regard leukæmia as a substantial prop to the theory of cellular pathology which was clearly enunciated by Rudolph Virchow (1858), himself one of the foremost investigators of human leukæmia.

Leukæmic conditions are found with some frequency in birds and mammals. Fowl leukæmia is most often a disease of the lymphocytes, whether they are circulating in the blood stream or confined to certain regions such as the lymph glands, spleen or bone marrow. There is a close resemblance between these lymphogenous leukæmias and the economically important 'fowl paralysis' (neuro-lymphomatosis). Curious seasonal variations are seen with fowl leukæmia, reminiscent of the seasonal variations in rate of growth, fatality and transmissibility of certain fowl tumours (sarcomata) induced by carcinogenic agents (Peacock, 1935).

Spontaneous leukæmia is also found in adult dogs, pigs, cattle and rodents. In the mouse it is a common disease occurring in forms very like those known in human beings, so that mouse leukæmias have been intensively studied. Various kinds of white blood cells are affected and enormous numbers of such newly formed cells appear in the blood, while the organs in which these cells are normally congregated (lymph glands, spleen, bone marrow and to a lesser extent the liver) may be greatly enlarged from massive deposits of abnormal cells. On the whole, birds and mammals show an absolute preponderance of leukæmias in which the lymphocyte is the chief cell affected.

Among the many varieties of fowl leukæmia are some which can be transmitted to healthy birds by cell-free centrifugates and filtrates (Ellermann and Bang, 1908). Transmission succeeds with remarkably small doses. Furth (1932) found that as little as 0·000001 c.c.m. fowl plasma could transmit the disease. Chickens a few days old are more susceptible than adult fowls, and seasonal variations in 'takes' are known. A filterable virus is naturally enough thought of as the cause. There is evidence that the virus of fowl leukæmia is not strictly species specific, for it can be transmitted to guinea fowls, pheasants and turkeys. When introduced into the blood of susceptible birds, the virus disappears from the blood vessels for a time, localizing in the bone-marrow and possibly spleen and liver, where it induces proliferation of blood cells. The virus is about 65–75 mμ in size, is thermo-labile, survives prolonged drying, is destroyed by oxygenation, but resists irradiation. It can be cultivated *in vitro* only in the presence of cells. Thus it has many resemblances to the causative virus of the Rous sarcoma of fowls. There is evidence of natural immunity in some birds and active immunization has succeeded.

Transmission of leukæmia is also possible in rodents. In non-inbred strains of mice, transmission succeeds in animals of similar genetic constitution. In mixed strains, transmission fails unless resistance is lowered by X-ray exposure. Inbred strains can be produced with a high incidence of spontaneous leukæmia. The disease can be transmitted only by means of living cells, no cell-free virus having been demonstrated. A single cell injected intravenously may suffice to transmit the disease (Furth and Kahn, 1937). Dispersion and multiplication of such cells, apparently without co-operation of the host's tissues, is responsible for the disease. There is, however, some evidence that metabolic changes, somewhat like those seen in malignancy, occur in lymph glands of leukæmic strains before morphological signs of leukæmia can be recognized (Victor and Potter, 1935), but much more work is required on this obscure subject.

The importance of heredity in spontaneous animal leukæmias has been extensively studied, especially in mice. It would appear that there is a maternal, non-chromosomal factor which differs from the milk-transmitted factor demonstrated by Bittner (1939) in the case of cancer of the breast in some mouse strains. Hereditary factors play an important part in susceptibility to transmitted leukæmia, but the genetic constitution of the tissue inoculated complicates the experiment. Mice of an inbred strain susceptible to inoculation with tissue from one line may thus be resistant to leukæmic tissue from another line.

It has been claimed at various times that experimental leukæmia can be produced by the action of carcinogenic substances, just as sarcomata are produced by these. Striking blood changes do occur in such circumstances, but they are not wholly convincing of leukæmia and are seldom accompanied by blood-cell infiltration of the tissues. Investigators have preferred to speak of them as leukæmoid changes, reserving for the future the right to change their views as to the true nature of such conditions. In mice of known genetic constitution showing a very low incidence of spontaneous leukæmia the condition can be produced by carcinogenic agents. Thus in the Aka strain in which 50–70 per cent of animals more than eight months old develop lymphogenous leukæmia, carcinogens induce sarcoma and carcinoma as well as leukæmia in mice less than five months old (Engelbreth-Holm, 1940). Such treatment seems to accelerate both tumour and leukæmia production. The incidence of leukæmia can also be increased in mixed stocks and purer strains by irradiation with X-rays or by œstrogens.

It is not surprising, therefore, that many investigators now accept Ribbert's (1904) view that leukæmias in animals are neoplastic in nature, but whether they are truly malignant or benign is not certain. There is no clear-cut border-line, however, between lymphogenous leukæmia and lymphosarcoma in mice. Leukæmic disease, as with new growths, commences as a local change and becomes generalized, any differences being explained as consequences of the special relationship of leukæmias to the vascular system. Since there are so many clinical and pathological analogies between the animal and human leukæmias it is obvious that investigations into their relationship to viruses, transmissibility and genetic constitution hold out a good deal of promise for the future, and man may once again be indebted to his humbler relatives for the solution of a baffling problem.

Dr. Engelbreth-Holm, director of the Cancer Research Laboratory of the Danish Anti-Cancer League and himself an original worker on animal leukæmias, is to be congratulated on a fascinating book written at the invitation of the Scientific Advisory Committee of the Lady Tata Memorial Trust. Not only research workers in this very specialized field of blood diseases but also all who have an interest in the progress of experimental medicine will enjoy the clear presentation of a variety of facts drawn from a widely dispersed literature. Special commendation is due to the translator of the Danish manuscript, the editors of the English version and the librarian of the National Institute for Medical Research, London, who checked the references, for their labours.

G. R. CAMERON.

CONDITIONED REFLEXES

Lectures on Conditioned Reflexes

Vol. 2: Conditioned Reflexes and Psychiatry. By Prof. Ivan Petrovitch Pavlov. Translated and edited by Dr. W. Horsley Gantt. Pp. 199+7 plates. (London: Lawrence and Wishart, Ltd., 1941.) 8*s*. 6*d*. net.

ONE is often grateful for the existence of general surveys which are written for international congresses or commemorative volumes. They provide excellent opportunities of summarizing a subject in a form which gracefully supplies entertainment and instruction. It is very doubtful, however, if there is any justification for the collection and republication of the general reviews written by a single author. Inevitably they cover large areas of the subject, and inevitably they overlap. Brief accounts of the same illustrative experiment reappear time after time, until one longs for tables of data and experimental protocols. Of the fifteen chapters in this volume, eleven consist of general articles. The translator has carried out extensive condensation and excision, but far too much that is redundant remains.

The last chapter is by far the best. It was written in 1935, the year before Pavlov's death, and in it he has summarized in twenty pages the whole of his work on conditioned reflexes. It is the most complete and orderly presentation in the book. The other outstanding chapter appeared in the *Psychological Review* in 1932, translated by Dr. R. S. Lyman. Its style is clear and vigorous, and the subject-matter is scientific polemic at its best. Pavlov defends himself against Guthrie and Lashley by a masterly restatement of his own position, and his criticism of Lashley is fair and penetrating. His comments on experiments on maze-running exemplify his approach to a problem and his instinct for profitable analysis.

The remainder of the book is disappointing. The translation is obscure and clumsy, and there are no references. The introduction contains a biographical sketch of Pavlov's later years, and a section entitled "A Critical Evaluation of Pavlov's Work". This consists of a hotchpotch of the considered and unconsidered opinions of physiologists and psychologists, and a remark addressed to the author by Bernard Shaw at Lady Astor's.

Since 1927, Pavlov and his school seem to have turned their attention chiefly to the study of the disturbances of behaviour, which he calls experimental neuroses. The methods used include the application of very strong stimuli, the protracted use of inhibitory stimuli, the presentation of positive and inhibitory stimuli in quick succession, and castration. On the basis of their behaviour in these conditions, Pavlov divides his dogs into choleric, sanguine, phlegmatic and melancholic types. This classification depends on incompletely defined concepts of 'strong' and 'weak' nervous systems, but it is claimed that it is of use in the production of neuroses at will, and in their cure by appropriate treatment.

When he was more than seventy, Pavlov plunged into the study of human psychiatry. He began to attend psychiatric clinics, and re-opened the writings of the clinical psychiatrists. Naturally, he began to interpret these new phenomena in more familiar terms. In these lectures, analogies abound between human neurasthenia and experimental neuroses, between schizophrenia and chronic hypnosis in dogs. Paranoia and obsessional neuroses are said to be manifestations of pathological inertia of points of the cortex. The classification of men into artists and thinkers, and the conception of words as conditioned stimuli of a second order are further examples of Pavlov's passion for simple hypotheses with which to try to reduce chaos to order.

It is a pity that Pavlov did not begin by trying to verify in man his conclusions from animal experiment. Instead, he writes as one bringing light to the blind. In 1927, he began the last chapter of "Conditioned Reflexes" with a firm warning against the premature application of "these first steps in elucidating the physiology of the cortex . . . to the intricate problems of the higher psychic activities in man, when at the present stage of our work, no detailed application of its results to man is yet permissible". It is difficult to feel that the subsequent experimental work described here has provided the evangel that alone could justify Pavlov's disregard of his own warning. He even supplies evidence himself that his results on the dog are not, in fact, generally applicable. Speaking of the spread of prolonged inhibition over the hemispheres in a dog, he remarks that "this has been shown from the experiments by Voskresensky on monkeys, to be a special property of the dog's nervous system". In spite of this, we find that this spread of inhibition over the cortex is invoked to explain sleep, hypnosis, and the states of hebephrenia and catatonia in man.

The main difficulty in Pavlov's work, the extreme complexity of conditions from which the stimulus had to be isolated, was brilliantly overcome. The second major difficulty, the degree to which experimental conditions interfered with normal cortical function, he at least recognized: "Hypnotization begins when the dog enters the experimental room, sometimes even before he gets on the stand, increasing as the experiment progresses". The insuperable difficulty was that Pavlov was limited to external observation of stimulus and response. He could trace roughly the anatomical pathways involved, but could know nothing of the intermediate processes. Studies on the whole animal must always be interpreted in the light of analytical experiments, and in the absence of such knowledge it is not surprising that Pavlov has bridged the gap between stimulus and response by a mass of hypotheses. Sometimes, by varying his conditions, he has been able to weed out false hypotheses, but often they are left to buttress one another. Attempts by others to re-interpret his data have not been more successful. Denny Brown's substitution of 'attention' and 'distraction' for Pavlov's 'irradiation' and 'waves of inhibition' seems to depend on personal preference, and the great advances in our knowledge of the behaviour of the spinal cord in the last ten years have made interpretations based on classical cord physiology look a little premature.

With the development of a real physiology of the cortex by Adrian, Bremer and Dusser de Barenne, a surer basis for interpretation is being built up. It is already possible to put some of Pavlov's broader hypotheses to experimental test by electrical methods in the intact animal. Studies of cerebral activity in animals will for long be based on Pavlov's work, and the English-speaking worker will turn first to Anrep's translation of "Conditioned Reflexes". If the present volume induces new students of cortical physiology to turn back to that great work, it will have been of lasting value.

D. WHITTERIDGE.

SEPARATION OF ISOTOPES AND THERMAL DIFFUSION*

By PROF. JAMES KENDALL, F.R.S.
University of Edinburgh

THE fact that the same element may exist in two or more forms, which are chemically identical even though their atomic weights differ, was first noted by Soddy (1910) in connexion with radioactive elements. A little later Sir J. J. Thomson (1913) showed, by the method of positive ray analysis, that neon, with an average atomic weight of 20·2, is a mixture of two kinds of atoms with masses 20 and 22 respectively. The brilliant extension of this method of attack by Aston established that most of the common elements are similarly inhomogeneous. Chlorine (35·457) is a mixture of ^{35}Cl and ^{37}Cl; tin (118·70) exists in as many as ten forms, with atomic masses ranging from 112 to 124. These chemically identical species of the same element with diverse masses are known as *isotopes*.

The separation of isotopes has been strenuously attempted by many chemists during the last twenty-five years. There is only one instance where Nature has, in a sense, performed this separation for us—lead derived from uranium disintegrations consists mainly of the isotope with mass 206, while lead derived from thorium disintegrations contains chiefly the isotope with mass 208. In all other cases the proportions of the various isotopes of any particular element appear to be practically constant, whatever the source. Partial separation has proved possible, although exceedingly difficult, in several investigations; complete separation was first achieved in 1933 with hydrogen.

This lecture summarizes, in the main, a series of researches in this field which I and my co-workers have carried out since 1919.

Ionic Mobility

A long-standing controversy has been waged on ionic mobility; one school insisting that ionic mobility is fundamentally dependent upon ionic volume, another being equally confident that it is fundamentally dependent upon ionic mass. The results available in the literature for homologous series of organic anions and cations have been utilized by both parties to prove their respective points; but, since we have no definite knowledge as to what amount of solvent accompanies any ion in its journey towards an electrode, and since it is the *total mass* or *total volume* of the ion and of its accompanying solvent envelope which must be taken into account, such data obviously offer us no means for definitely determining the problem.

The discovery that isotopes possess equal atomic volumes first put us in a position to impose a crucial test, for isotopic ions necessarily *differ in mass*. If mass is influential, therefore, it should be possible to obtain a separation of isotopes by taking advantage of the fact that the lighter ion will migrate more rapidly than the heavier. This idea of an 'isotopic race', however, cannot be carried out experimentally as simply as it might seem at first sight. Ions do not compete under the influence of the electric current in the manner of a track meet, unless we extend our experiences to imagine a continuous relay race. We cannot start all of our ions at one point and obtain a separation by noting when those of a certain species have passed a given goal, for there must be maintained a steady supply all the way from one electrode to another in order for the current to pass, and it will not help us much if a faster ion hurries ahead of its slower neighbour, since it will merely find itself in the company of other slower ions which happened to start a little in advance. By a modification of the experimental procedure, nevertheless, our 'isotopic race' may be converted into a 'parade' which can be suitably regulated.

The apparatus used is shown in the accompanying diagram, and its applicability may be illustrated by a condensed description of the technique employed in the case of chlorine.

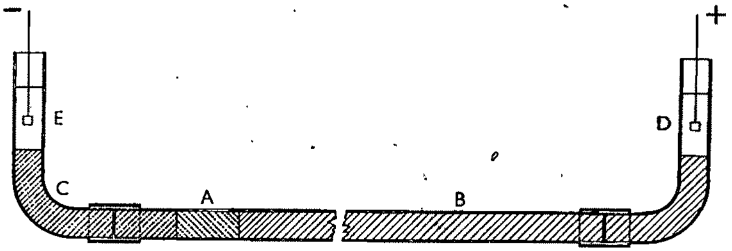

Fig. 1.

An agar-agar gel A containing sodium chloride is inserted as a short middle section in a long horizontal tube of Pyrex glass, one and a half inches in internal diameter. On one side of the chloride gel is added a gel B containing sodium hydroxide; on the other side a gel C containing sodium acetate. The ends of the tube are connected with right-angled Pyrex bends of the same diameter, and the gels continue well up into these bends, as in the diagram. Above the hydroxide gel, after it has set, is poured concentrated sodium hydroxide solution D, and above the acetate gel a solution E of sodium acetate in concentrated acetic acid. Platinum electrodes are placed in these two solutions, and a current is passed through the tube, the electrode in D being made the anode and the electrode in E the cathode. The heating effect of the current upon the gel may be minimized by submerging the tube in a long trough filled with running tap-water.

At the beginning of the run, the boundary surfaces between the various sections of the gel are perfectly sharp. When the current is turned on, the boundaries move towards the anode. Inasmuch as there is a faster-moving ion in front of the chloride ion, and a slower-moving ion behind it, admixture of the salts is absolutely prohibited and the boundaries remain distinct throughout the whole experiment. In order to maintain the width of the chloride section approximately constant, it is well to arrange the concentrations of the various salts in their respective gels in accordance with the transference numbers of their anions. Even if this is not done exactly, however, the boundary concentrations soon automatically adjust themselves to the required ratios.

The rate at which the boundaries move depends upon the potential drop between the electrodes, the length of the tube, and the concentrations of the solutions. In actual practice, the horizontal tube is made up of several three-foot sections connected by rubber bands, and the current is regulated (100–500 volts) so that the boundaries advance about 12–18 in.

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* From a lecture at the Royal Institution, delivered on May 8.

a day. When the front chloride boundary has almost reached the end of the tube, the apparatus is taken apart. The two rear sections are discarded, two new sections filled with hydroxide gel are inserted in front of the chloride, and new bends are fitted on as before. The chloride ions are now forced to migrate into these two new sections, and the whole procedure is repeated until they have progressed through about 100 ft. of the gel. The chloride gel is then removed from the tube and immediately cut up into strips about 1 cm. in width.

If, now, the isotopic chloride ions with atomic masses 35 and 37 respectively possess significantly different mobilities, the front segments of the gel will contain only the faster-moving and the rear segments only the slower-moving isotope. Preliminary experiments in which a mixture of two sodium salts with anions of known mobilities was substituted for the middle sodium chloride section fully demonstrated this point. Thus, when a mixture of sodium iodide and sodium thiocyanate was employed and the boundary was moved only a few feet, the front segments were found to contain only sodium iodide and the rear segments only sodium thiocyanate. The observed lag of the slower ion was almost exactly equal to that calculated from the difference in mobilities. In this particular case the difference is approximately 16 per cent. In subsequent experiments this difference was narrowed by choosing other suitable pairs of ions: for example, barium and calcium, barium and strontium, and iodide and chloride. The differences in mobilities are here reduced to 8 per cent, 5 per cent and 1 per cent respectively, and the results obtained showed that the method could be depended upon to provide a very considerable degree of separation even at the lowest limit tested.

It was highly disappointing, therefore, to be forced to admit from the results of all our experiments with isotopic ions that no significant separation could ever be detected. The only conclusion that can logically be drawn is that the mobilities of isotopic ions are well within 1 per cent of equality, and that those workers are substantially justified who contend that volume is the decisive factor in determining ionic mobilities. Later theoretical advances, it must be added, support this view, although the matter is still not absolutely settled (Jette, 1927).

Although all the work on isotopes, as has been stated, led to no successful separations, yet the positive results obtained in the test experiments on known mixtures did inspire the hope that the ionic migration method might, after all, prove of practical service in the separation of more familiar materials which are ordinarily obtained by the chemist in a pure state only with extreme difficulty. The most important example of this type is furnished by the family of the rare earth metals. The group of elements known as the rare earths comprises the elements of atomic number 57 to 71 inclusive, and yttrium with atomic number 39. These elements are distinguished by such extraordinary alikeness in chemical and most physical properties, due to the identical arrangements of the two outer shells of electrons in their atoms, that they actually approach isotopes in similarity. It is necessary, in practice, to take advantage of slight differences in solubility observed for corresponding salts and to resolve a given mixture into its components by a long series of fractional crystallizations or precipitations, ranging in number from several hundred to many thousand, according to the elements present and the degree of purity desired. These operations are so laborious and time-consuming that chemically pure samples of individual rare earth compounds are practically unknown, save on the shelves of a few skilled workers in the field of atomic weights. The 'rareness' of the rare earths is due not so much to the lack of abundance of their ores in Nature as to the lack of a simple method for their separation.

The first separation attempted was upon a mixture of yttrium and erbium, kindly furnished by Prof. James, of the University of New Hampshire. Potassium was used as a preceding faster ion and trivalent chromium as a following slower ion. Not only could the position of the rear boundary be more conveniently followed in this particular case because of the colour of the chromic solution, but it was also found possible to observe the actual progress of the separation within the rare earth section in a very simple way by means of a small direct vision hand spectroscope. The majority of the rare earths give solutions with characteristic absorption spectra, and, by noting the increase or decrease in intensity of the most prominent lines in various parts of a section, the experimenter could immediately detect any change in composition in the whole length of the section without interrupting the run. Here yttrium rapidly accumulated in the front half of the section and erbium was relegated to the rear. After a run of fourteen days, during which the boundaries moved two metres, an almost perfect separation had been effected.

The next mixture tested consisted of neodymium and praseodymium, two elements which are so nearly alike that their first differentiation by Otto von Welsbach still forms one of the triumphs of technique in this difficult field. Neodymium salts exhibit a purple solution in water, while praseodymium salts give a green solution. A beautiful crystal of neodymium nitrate and an equally fine specimen of praseodymium sulphate were secured from the Chandler Chemical Museum of Columbia University and the careful work of several years was deranged in a few minutes by mixing these two salts to obtain a solution with an intermediate neutral tint. With this solution as a central section and with the same arrangement as in the preceding experiment, it required only a few days migration to disclose the fact that the front portion of the section was becoming distinctly green and the rear portion purplish. Observation by means of the spectroscope simultaneously showed that the characteristic absorption lines of praseodymium were becoming more pronounced in the front section and fading out in the rear, with the opposite behaviour for the neodymium. At the end of ten days, substantial progress towards a final separation had been accomplished.

Experiments with other mixtures of rare earths showed that, while complete separation could not be secured in every case, yet in most mixtures the mobilities of the ions were sufficiently divergent to compel a very rapid concentration of one particular component in the front or in the rear section. The method may, therefore, be considered as a general new method for obtaining pure samples of the rare earth elements with the expenditure of much less time and trouble than is required by the classical method of fractional crystallization (see, however, Selwood and Hopkins, 1929).

Important industrial uses for the rare earth elements will undoubtedly be discovered as soon as more convenient means for their isolation are developed. Aluminium remained a chemical curiosity until this same end was achieved, and while the later members of the aluminium family may not duplicate the successful career of their brilliant brother, yet it would indeed be strange if Nature had omitted to endow them, alone of all the elements, with no properties of service to mankind.

The success of the experiments with rare earths suggested that the method might be applicable to the separation of radium from barium. The concentration of radium from the barium residues of carnotite ores at present involves a very tedious series of fractional crystallizations, and, since it had already been found that barium could be separated from the other elements of the alkaline earth family by the method here under discussion, it appeared very probable that a similar separation from radium, the last member of this same family, could also be accomplished. Samples of barium residues containing known amounts of radium and of mesothorium (an isotope of radium) were obtained and, after a few days migration, the sections were cut into segments and their radioactivity examined. It was found that the radioactive components of each mixture tested accumulated very rapidly in the front part of the section. The ease of the separation in this case is so striking as to suggest that the ionic migration method may come into technical use for the concentration of radium in barium residues.

An attempt to separate hafnium and zirconium did not lead to such conclusive results. Hafnium exists to the extent of several per cent in all zirconium ores, and the similarity in properties is so pronounced that the actual discovery of hafnium was not definitely established until 1923. A sample of hafnium-rich zirconium oxide was kindly furnished us by Prof. Hevesy. The elements were not amenable to separation by the ionic migration method in the form of positive ions, owing to hydrolysis, and only after considerable search was a suitable negative complex ion discovered in the form of a complex oxalate. After long migration, analysis showed a very slight accumulation of hafnium in the rear of the section, the mobilities of the complex anions being evidently so close together as to render a complete separation impracticable.

The results in an entirely different field have been of better promise. Many of the alkaloids particularly useful for medicinal purposes are derived from natural sources as mixtures of several individual members which can be separated by the ordinary methods of organic chemistry only with great difficulty. The alkaloids, however, are weak bases which form soluble hydrochlorides, and the mobilities of the cations of these salts are not identical. It should, consequently, be possible to obtain a pure sample of an especially valuable alkaloid from the mixture of similar materials with which it naturally occurs by use of the ionic migration method, and several preliminary experiments indicate that the method is indeed applicable in a majority of cases.

Ionic Discharge Potential

Isotopic ions differ only in their minute nuclei, and these are surrounded by a relatively distant cloud of external electrons, increasing in number as we proceed up the periodic system. When an ion is discharged at one of the electrodes during the process of electrolysis, all that happens is that one or more electrons is added to, or taken from, this external cloud. Although, therefore, the free energy changes involved in the discharge of two isotopic ions are not necessarily identical, it is unlikely that the discharge potentials will be markedly different in the two cases, when expressed in volts. If we could pass an electric current through a solution containing two isotopic ions, adjusting the voltage so that the decomposition potential of one species was *just exceeded* while the decomposition potential of the other species was *just not attained*, then a perfect separation should be feasible. Owing, however, to the impossibility of adjusting the voltage with sufficient delicacy, and to the fact that reverse interaction of the discharged material with the solution, unless its immediate withdrawal from the system was effected, would probably tend to re-establish equilibrium conditions fairly rapidly, it appeared that the utmost that would be attainable in practice would be an 'electrolytic fractionation'.

Encouragement that a partial separation might be achieved by this method was derived from the knowledge that it is possible to vary the composition of a tin-lead alloy, obtained by electrolysis of a mixed solution of tin and lead salts, very significantly by varying the voltage employed. The discharge potentials of tin and lead ions differ by approximately 0·01 volts, so that it seemed that there was a likelihood of being able to establish some slight degree of separation of isotopic ions by fractional electrolysis, even if their discharge potentials were still more nearly identical.

The choice of an element to test the method presented great difficulty. Other things being equal, a light element would obviously be preferable, since the external electrons are fewer in number and shield the nucleus less effectively. The experimental obstacles in the case of lithium, the lightest known isotopic element at the time when this work was started (1921), are, however, exceptionally grave, owing to the activity of the free metal and to the elaborate technique necessary for its exact atomic weight determination. Other light elements presented similar objections, and the selection finally fell upon mercury. It is true that mercury is very near the wrong end of the periodic system, its isotopes ranging in atomic mass from 197 to 204, but the free metal is inert and the smallest change in its average atomic weight can be immediately and readily detected by means of density determinations. It was consequently decided to attempt the fractional electrolysis of mercury first, and to continue with lithium later, if the results obtained were sufficiently promising.

The results obtained have been presented in detail in a Ph.D. thesis from Columbia University (Haring, 1924). Electrolysis of an acid solution of mercurous nitrate, using a low voltage and low current density, gave mercury with a density only 0·999981 that of ordinary mercury. This value was the average of fourteen different electrolyses. Parallel experiments in which a high voltage and high current density were employed gave mercury with density unchanged.

The reduction in density, it will be seen, was only nineteen parts per million, which represented three times the average deviation of the individual results. The greatest difficulty encountered in the whole investigation was the exact setting of the mercury level in the pycnometers and, although the error involved thereby was minimized by repeating each setting five times and averaging the results of the five weighings, the probable error involved still amounted to 7·5 parts per million. This fact, together with the disappointingly small change (0·004 unit) in the average atomic weight of the electrolysed mercury, discouraged us from proceeding further at the time.

I have always been convinced, however, of the reality of the fractionation indicated and, in the expectation that more conclusive results would be obtained with a lighter element than mercury, Mr. McLaren of Syracuse University began a systematic study of the electrolytic method of isotopic fractionation under the direction of myself and Dr. Ludlam at the University of Edinburgh in 1930. A considerable amount of work had been done on lithium, but no final results attained, when the discovery of the isotopic character of hydrogen turned our attention early in 1932 to that element, which obviously offered still greater chances of success. Spectrographic evidence suggesting that the proportion of the heavier hydrogen isotope in the first fraction of the electrolysis of water was less than in ordinary hydrogen had been obtained when parallel investigations in the United States were brought to a successful conclusion. The isolation of pure 'heavy' hydrogen and the preparation of pure 'heavy' water from the final fractions of the repeated electrolysis of ordinary water must be regarded as one of the most significant achievements in chemistry in recent years. It is disappointing to have been anticipated, but there is some consolation available in being the first to employ the method by which the separation was made.

Thermal Diffusion

Since 1933, striking advances in the separation of the isotopes of heavier elements have been made, notably by the chemical exchange method of Urey, but perhaps the most promising general line of attack is that opened up recently by the work of Clusius and Dickel on thermal diffusion.

This property was originally noted by Ludwig in liquids so long ago as 1856. Ludwig placed a solution of sodium sulphate in a U-tube, one limb of which was kept in boiling water and the other in melting ice, and found that after two days solid crystals had separated out in the cold limb, while the concentration in the hot limb had decreased to one half. Soret (1879) made measurements of the same kind with various salts, employing vertical tubes with the upper part heated and the lower part cooled, and his results were utilized, not very justifiably, by van 't Hoff (1887) in confirmation of the applicability of the gas laws to solutions.

Thermal diffusion in gases was first discussed by Enskog (1911) and predicted independently by Chapman (1917). In the latter year, Chapman and Dootson achieved a partial separation of a mixture of carbon dioxide and hydrogen contained in two glass bulbs connected by a capillary tube, with a temperature difference of 210°. The theory of the process, both for gases and for liquids, however, remained obscure, as will be evident from the fact that Chapman, in 1929, pointed out that existing theories did not even indicate with any certainty the sign of the slight amount of fractionation generally obtainable.

Only in 1938 did thermal diffusion suddenly come into practical prominence through the astoundingly simple discovery that the substitution of a horizontal for a vertical temperature gradient enhanced the effect to an enormous degree. In the older forms of apparatus, convection currents were deliberately avoided, but Clusius and Dickel ingeniously used such currents to assist the normal thermal diffusion process by what has been called 'thermo-syphon action'.

This action is illustrated in the accompanying sketch, where the convection currents set up in a narrow rectangular vessel with opposite heated and cooled surfaces are indicated by arrows. Normal thermal diffusion establishes a small concentration gradient in the direction *AB*, the concentration of the lighter component of the gas or solution contained in the tube increasing at *A* and decreasing at *B*. The upward convection current consequently causes the ascent of excess lighter molecules, the downward current the descent of excess heavier molecules. A second concentration gradient is thus developed in the direction *CD*, and the steady continuation of the process may ultimately establish, under suitable conditions, a complete separation of the two components of the original mixture.

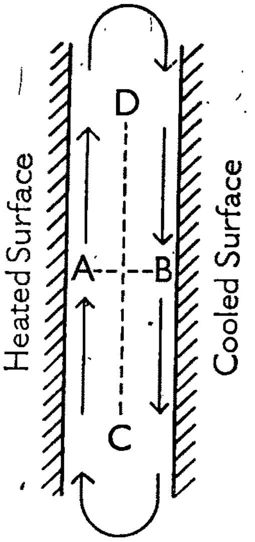

Fig. 2.

An improved form of apparatus devised by Clusius and Dickel for use with gases consists of a long vertical glass tube, externally cooled, with an electrically heated platinum or nichrome wire running down its centre. With a series of successive tubes, altogether 36 metres in length, Clusius and Dickel succeeded in obtaining from ordinary hydrogen chloride top samples corresponding with a 99·6 per cent content of the lighter isotope of chlorine and bottom samples corresponding with a 99·4 per cent content of the heavier isotope. This represents so far the only reasonably complete separation secured by the thermal diffusion method, but the applicability of the method to other cases is obvious.

Considerable work, though practically all of a preliminary nature, has also been done on thermal diffusion in liquids since 1938, and I shall conclude with an account of some simple experiments carried out in my own laboratory by Taylor and Ritchie. The solutions employed are enclosed in a vertical annular space, less than 0·5 mm. in diameter, between two concentric glass tubes, approximately 1·5 metres long. A temperature gradient of about 80° is maintained across this space by the passage of a current of cold water through the inner tube and a current of steam through a surrounding jacket. Eight hours of thermal diffusion of a solution of copper sulphate fractionates it so thoroughly that a goodly crop of crystals will separate out at the lower end, while the characteristic blue colour of the salt will entirely disappear from the uppermost section. Two hours of thermal diffusion of a solution of copper bromide suffices to develop the characteristic reddish-brown concentrated coloration and the bluish dilute colour at opposite ends of the tube. A solution of cobaltic chloride after two hours of thermal diffusion clearly exhibits the deep blue and pink of concentrated and dilute solutions at its upper and lower ends.

It will be evident that thermal diffusion represents a most valuable new tool at the disposal of the chemist, facilitating separations of a most diverse character. One practical point that has already come up for investigation is the influence of thermal diffusion on ingot segregation in steels. Metals are such good conductors of heat that it seems unlikely that any steep temperature gradient could persist for a sufficient length of time in the liquid contained in an ingot mould for thermal diffusion to induce significant segregation. At the suggestion of Dr. C. H. Desch, however, an experiment to test this point was undertaken in my department by Dr. Ritchie. The apparatus employed was similar to that already described, but the annular distance was reduced to 0·25 mm. and the length of the concentric tubes increased to 2 metres. The annular space was filled with a solution of 1·5 per cent zinc (density 7·1) in mercury (density 13·6). Even under such favourable conditions, no fractionation whatever was observable after a run lasting for 32 hours.

This negative result is no doubt largely due to the high thermal conductivity of the amalgam, which reduces the temperature gradient by making the drop between the annular liquid surfaces much less than that between the surrounding glass walls. The same factor, however, as has been noted above, should also diminish the effect of thermal diffusion in ingots. Further work in the field is obviously necessary, but in the meantime the view expressed by Desch that thermal diffusion cannot play an appreciable part in producing the observed segregation in steel ingots appears to be fully justified.

FUTURE OF THE POPULATION OF GREAT BRITAIN

By COLONEL SIR CHARLES ARDEN-CLOSE, K.B.E., C.B., C.M.G., F.R.S.

AN interesting memorandum, entitled "Current Trend of Population in Great Britain", was presented to Parliament by the Minister of Health and the Secretary of State for Scotland in May 1942*, but it is explained, in the opening paragraph, that this memorandum was actually "submitted shortly before the outbreak of the war by the Registrars-General of England and Wales and of Scotland to the Royal Commission on the Geographical Distribution of the Industrial Population". It was not included in the papers published by that Commission. The facts dealt with are those available up to April 1938 and no account is taken of the War.

The memorandum is in the form of a compact little pamphlet of twelve pages, with tables and two diagrams. The account is somewhat compressed and requires attentive study. It brings our knowledge of the facts reasonably well up to the date mentioned, and, with the aid of certain assumptions, gives indications of what our numbers might be twenty or thirty years hence; but it has to be borne in mind that the assumptions do not include the possibility of war.

The main intention of the memorandum is stated to be the presentation of the facts in as objective a manner as possible, so as to correct misunderstandings based on rather sensational forecasts as to what might be the fate of the population of Great Britain a century or so hence. A warning is given that forecasts extending to such a distant future have very slight value.

It is stated that, "as long ago as 1926, attention began to be drawn in official reports to the significance of the phase which the falling birth-rate was then entering". The crude birth-rate, which reached its maximum of 35·4 per thousand of the population in the period 1871–75, after that showed a continuous decline until the year 1933 when it reached the low figure of 14·7, "from which time the fall appears to have been arrested and a minute, though so far uninterrupted, reverse of the movement taken its place". The estimated figure given for 1938 was 15·5, but actually it was 15·1. We can bring the figures up to date, thus: 1939, 14·9; 1940, 14·6; 1941, 14·2. These figures are later than the date of preparation of the pamphlet; they are obviously affected by the War and will not serve as a guide to future peace-time rates, for it must be remembered that great wars, such as the War of 1914–18, or the present War, do materially diminish the populations of the countries engaged in them; the population of Great Britain was probably some two millions less at the time of the census of 1921 than it would have been had there been no war a few years before.

A table is given to show the average annual percentage of increase of our population, and from this it appears that between 1871 and 1911 the average annual increase was 1·12, but after 1911 there was a marked drop and the average increase up to 1938 was about 0·45. The most striking drop was from 0·98 in 1901–11 to 0·46 in 1911–21, that is, the most marked change occurred in the war period "when the rate of increase, which, prior to that time had been of the order of 1 per cent per annum, dropped to rather less than half that figure, at which level it has been maintained ever since".

It is well known that since 1923 the birth-rate has not been sufficient to provide a stationary population; in fact the births are only, by Dr. Kuczynski's calculation, about three quarters of the number required to reach that standard, in spite of the present continued increase of our numbers. Later information puts the net reproduction-rate, in 1938, as 0·84, so that fertility would have had to be raised by about one fifth to result in a stable population. To illustrate the "transitory and unbalanced nature of the present age distribution" a comparison is made between this and two theoretical stationary populations, resulting in each case from a constant annual number of births of 700,000, with different rates of mortality. It is stated that the comparisons show that the population would be maintained at or near its present level of forty-six millions if there were continued the flow of 700,000 births which were registered in 1937. But, of course, the supposition of a continued, constant flow of this kind "could only be realized by a gradual rise in fertility over the next two or three decades". It is added that such a recovery might possibly be secured "with the aid of measures ensuring a national population policy".

The male section of the important group 15–45 is now much smaller than the female section of that group. It is possible that this inequality is not sufficiently stressed by demographers. The marriage-rate must be adversely affected by such a disparity. We all of us know of women who have lost their prospective husbands in the War of 1914–18, and of others who found themselves in a world which contained too few marriageable men. If we think only of the number of marriageable women we shall be apt to forget the question of whom they are to marry. The Registrar-General for England and Wales reported in 1940 that there were more than a million and a half surplus women of marriageable age in the middle of 1939. The present War is not going to make this state of things any better.

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* H.M. Stationery Office, 1942. 2*d*. net.

An important consideration, too often neglected, is brought forward with regard to mortality. Too often it is assumed that the death-rates at the different ages have improved so much during the past two generations that further significant improvement is unlikely. Here we have clear indications to the contrary. A couple of diagrams are printed which show, in graphic form, the improvement in the death-rates of males and females, not only in the early stages of life, but up to, and including, the decade 75 to 85, in fact, practically for the whole of the normal life of man. In the construction of the diagrams the "death rates experienced in Great Britain over successive decennial periods between 1861 and 1931" are recorded for a series of age groups from 10 to 85. The general character of the curves so obtained is the same for all groups—all show an improvement. The curves have been extended by dotted, free-hand lines, which may be taken to show the probable death-rates at the various ages for the next thirty years. The ordinates (death-rates) are plotted on a logarithmic scale.

The authors are satisfied that this simple way of predicting the future is justified by consideration of statistical continuity, of the effect of curative medicine, and of the fact that some other countries have mortalities lower than Great Britain. It is noteworthy that the Registrars-General should have directed attention to the improvement in British mortality. There has been too much silence on this point on the part of unofficial persons and bodies who have, in recent years, studied the question of the future of our population. The Registrars-General remark that they "find no justification for the assumption, implied in some of the contemporary population forecasts . . . that the most probable course of mortality is one which shows no significant improvement on the rates actually experienced in recent years".

So much for mortality; and now for fertility. The line taken is that there was no diminution of the crude birth-rate in Great Britain after the low level (14·7) of 1933; that there was, in fact, a slight improvement. The values for the five years 1934–38 were 15·1, 15·1, 15·2, 15·2, 15·1. (The figure for 1938 was not actually available when the report was written, and an approximate value of 15·5 was given.) The pamphlet directs attention to the steadiness of the rate during these years, and it is remarked that "it would be unwise and unjustified to assume that any future departure from the present level is more likely to be in one direction than the other". It may here be noted that the Population Investigation Committee, in its publication "The Future of our Population", issued in 1936, put the average crude birth-rate in England and Wales as likely to be 12·4 for the five years 1935–39. This has proved to be wide of the mark.

As for the years 1939, 1940, 1941, the crude rates were 14·9, 14·6, 14·2; but these are war years and the only proper inference is that a world war has a disturbing effect on the birth-rate; this, indeed, is only common sense. The Registrars-General, then, make use of a constant fertility rate. The table on p. 9 of the pamphlet, which shows the effect of applying this rate, is somewhat difficult to follow, but we can accept the statement that the birth-rates were calculated with no bias in one direction or the other. Of course the calculations were made before the outbreak of the War and give no guidance for the war period, which may be a long one.

Since the pamphlet was published there has become available further information, based upon the data provided in accordance with the Population (Statistics) Act of 1938. From this it appears that married fertility has declined since 1921, at all ages of the mothers, decreasing to about two thirds of its previous value at 40–44; and the rate of child-bearing has decreased with the interval since marriage. This change is only explicable by deliberate family limitation.

The final factor dealt with is migration. It is assumed that, since the net outward migration from Great Britain for the years 1924–30 was 1·2 per thousand of the population, and the net inward migration for the years 1931–37 was 1·4 per thousand, that this inward migration would continue "up to 1941, followed by a gradual reduction to vanishing point in 1951, and nil thereafter". This forecast is now, owing to the War, valueless.

With these three factors, mortality, fertility and migration, thus determined, the authors proceed to gather up the results so far as concerns the numerical future of our population. They say that in their calculation there has been no conscious bias in either direction. There is, of course, a margin of uncertainty in the assumptions, and this uncertainty must render distant forecasts increasingly unreliable. But they make allowances for favourable and unfavourable variations in the basic assumptions, and give the effect of a ±10 per cent variation in the ultimate mortality and fertility to be reached in 1971, with proportionate differences in the intervening years. No variation is made with regard to migration. It is added that the forecasts "make no allowance whatever for such change as might ensue from the possible introduction of a controlled population policy in regard either to the birth rate or to migration".

Here are some of the final results:

TOTAL POPULATION OF GREAT BRITAIN (thousands)

Actual population 1937	1941	1951	1961	1971
46,008	46,565 ± 25	47,501 ± 280	47,192 ± 805	45,980 ± 1,579

Taking the lowest figure, we might, but for the War, have expected a population in 1971 of about 44½ millions, in place of the 1937 population of 46 millions. What is a matter of some concern is the age distribution which is shown in the same table. We see that in 1971, according to these calculations, the number of children under fifteen will have come down from 10 millions to 7½ millions; the numbers in the working ages 15–45 will have been reduced from 21½ millions to a little over 17 millions; and the category "over 65" will have increased from 3·9 millions to 7·9 millions. These are the troublesome features of a birth-rate which is insufficient, ultimately, to provide a stationary population. The mere reduction of total numbers might have certain advantages in such a very densely populated country as England. But the overloading of the country with people past work, or, at any rate, not equal to exerting the energy expected of the middle-aged, has no advantage at all.

These calculations would give a date for the attainment of the maximum population some time between 1951 and 1961. An unofficial estimate made in 1927 gave the year of the maximum as between 1949 and 1953. Dr. Enid Charles's estimates, published in 1935, based upon three different assumptions, and very carefully worked out, gave the year of the maximum as 1940, 1944 or 1960. All that we can say is that the maximum has not yet (1942) been reached, and that all estimates have been upset by the War.

We cannot tell how long the War will last, or how many of our young and middle-aged men will be killed or permanently disabled. But we do know that there is the certainty of the War's disturbing effect on the birth-rate, which has already dropped from the recent pre-war average of 15·1 to 14·2 in 1941. Moreover, war takes its chief toll from the young men, and the result must be that the disparity between the numbers of males and females will be still further accentuated, as also will be the ageing of the population as a whole.

To take a long view then, it would appear that, while we need fear no serious diminution of our numbers for the next generation, the population will grow steadily older, and if we wish eventually to attain a happy condition of equilibrium, with a satisfactory age distribution, and thus avoid dangerous decreases of population in the times of our grandchildren and great-grandchildren, we should take steps as a nation, now, to encourage an improvement in the birth-rate.

THE HUMAN FACTOR IN PRODUCTION*

By DR. MAY SMITH

Industrial Health Research Board

THE word 'production', like its fellow 'output', is an uninspiring word. Those of us who must use it for convenience need to remind ourselves at intervals that it is a general term and really stands for concrete things. Behind each article is an innumerable company of human beings, each with his hopes and fears, dreams and realities. This may be a machine age; industry may be mechanized, but personally I have never met the mechanized human being.

The work of any human being, like any other activity, can be affected positively or negatively by numerous causes, and a complicated web has to be unwoven if these causes are to be sorted out. Nor are all of them equally operative all the time; now one, now the other is thrown into relief with the others in the background.

Output is affected by the material and the psychological environments and by the physical and mental make-up of the individual.

Factors in the Material Environment

(*a*) *Lighting.* Natural lighting (daylight) is ideal when there is plenty of it. Since it is not available for night work, and for the ordinary hours of work in winter, and since the black-out has interfered still further, a satisfactory substitute has to be found. With inadequate illumination, output is reduced by a slower rate of working and by an increase of spoilt work. The liability to experience eye strain, 'nervous trouble' (probably irritability) and accidents is increased.

(*b*) *Heating.* Lack of warmth on one hand, and overheating on the other, cause discomfort. Experience gained during the War of 1914–18, and by investigations made since, has shown that efficiency falls when the temperature rises unduly—particularly in heavy industries. In industries such as iron and steel, tin plate and glass manufacture, output is lowest in the hot summer months and highest in the winter. Even in the lighter work of textile operatives, the work deteriorates as the temperature rises above the comfort zone. On the other hand, low temperatures adversely affect manual dexterity. Broadly speaking, those atmospheric conditions which are generally found to be comfortable are also those which are best from the point of view of efficiency and safety.

(*c*) *Ventilation.* The first requirement is an adequate supply of chemically pure fresh air. After that, attention has to be paid to the temperature, humidity and rate of movement of the air. War-time lighting restrictions interfere considerably with ventilation arrangements. When a night shift is worked, arrangements for securing adequate ventilation are even more imperative. The problem of obtaining this adequate ventilation is not a purely mechanical one; there is also a psychological factor.

(*d*) *Hours.* Within limits, an increase of hours will increase the output. The human being is not a machine, and this being so, he can by force of will drive himself to perform far more than he considered his maximum. There were endless examples of this in industry after the Dunkirk period. To do this, however, reserve energy has been used; he has as it were used his reserve energy; and such activity can only be carried on for a limited time, after which considerable reduction occurs. The result is that after a continuous period of overwork, improvement in output does not take place for a considerable time after the return to normal hours. The Health of Munition Workers' Committee of the 1914–18 War summed up thus: "Misguided efforts to stimulate workers to feverish activity in the supposed interests of output are as useless as would be the cheers of partisans encouraging a long distance runner to a futile sprint early in the race."

Even with normal hours of work, the long spells of four and a half or five hours should be broken up, preferably by organized rest pauses and not by accidental interruptions due to waiting for materials, etc. Most people can face with equanimity work of about two hours' duration and can keep a steady pace, but the prospect of five hours' unbroken work often exerts a retarding influence on speed. The effect of any continuous activity, whether physical or mental, is associated with a gradually diminishing success in that activity. The stages at which full success is replaced by partial success and eventually by failure are not the same for everyone, or constant for the same person. Anything that reduces the available energy of the worker, or his interest, will affect the stage at which reduction of effective work begins to take place.

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* Substance of a paper read on June 6 before a conference on "Social Biology in Relation to the War" arranged by the British Social Hygiene Council.

Fatigue is therefore a relationship between the amount of available energy, the nature of the work, and the attitude of the worker towards it. The remedy for fatigue is rest, and if work has been within reasonable limits, a night's rest will restore energy. If, however, in addition to the effects of hard or prolonged work, rest has to be taken in an air-raid shelter, or rest is impossible on account of the competing roar of guns and bombers, energy is expended instead of being renewed.

Apart from the diminished accuracy and speed consequent upon a fatigued state, there are well-known fatigue sensations, namely, a feeling of weariness, disinclination to make an effort, inco-ordinated movements, organic disturbances, irritability, listlessness. Consciousness of these sensations can distract a worker's attention from the work to himself. Since some of these symptoms are associated with certain diseases, it is not difficult for a fatigued person to think he is ill; the step to being ill is short.

The Psychological Environment

(*a*) *The mental atmosphere.* Diminished efficiency, weariness and an appearance of listlessness *may* still be present when the work is light and hours normal. These pseudo-fatigue effects are due not to the using up of reserve energy but to lack of interest, and are associated with repetitive work, of which there is a great deal; the sufferer is bored.

It must not be assumed that all workers find all repetitive processes boring. One worker will stigmatize a process as boring and find another interesting, whereas to the observer there was nothing to choose between them. It has been found that on the average about 26 per cent of workers experience considerable boredom at repetitive work. An investigation was made into filament winding, soap wrapping, chocolate packing and tobacco weighing, from the point of view of the relation of output and boredom. Results showed that the more intelligent suffered more from boredom than those of inferior intelligence, but there were individual differences, even among the intelligent. It is worth noting that one can be fatigued without knowing it, but not bored.

There are compensations, however, even in repetitive processes, if we consider the worker as a human being and not merely as the performer of a repetition process. Some workers, for example, experience a sense of power when operating a large or delicate machine, and where a machine is a unit there is often a strong sense of possession: "my machine", it is called. Some people find considerable relief in day-dreaming and declare that it makes the time pass quite pleasantly.

Repetitive movements must either be studied as such, in which case they belong to the psychology of habit formation, or else put in their complete setting, including at least the opinions of fellow-workers and authorities about the work, physiological changes, emotional changes, and the general collective life of the place. The total reaction at any one time will be a reaction to a composite situation which constantly changes and of a personality that changes.

(*b*) *Personality of the Authority.* By far the most important factor in the mental environment is the personality of those in authority. There is no correlation between being able to do a job oneself, and being able to superintend others doing it. The effect of power on many people is to let loose a number of qualities otherwise held in check and usually unsuspected; in some occupations it has proved possible to demonstrate the effects of people in authority whose childish emotional development has counteracted their intellectual and practical ability.

There is a price to be paid for inadequate ruling and that price may be the unhappiness of subordinates. Unhappiness, however, does not remain merely a mental state; it receives expression, and in the industrial world this can sometimes be measured, the usual means of expression being an inferior output, high sickness rate or high labour turnover.

In one investigation, four groups of clerical workers were specially selected for experimental purposes to be comparable so far as possible; detailed output records for the six months preceding the experiments were available. Each group was in charge of a departmental head new to the group. Daily records were kept for the next two years. Hence it was possible to compare each person's record during the periods preceding and following the selection. The immediate effect of one head was to increase not only the average output of her group by 10·3 per cent, but also the output of each worker, whereas another decreased it by 5·5 per cent. The work was similar, and the chief difference between the two extremes lay in the temperament of the heads, one being a particularly 'vital' person, the other a person who 'enjoyed' ill-health.

Selection of People for the Right Work

A certain amount of negative selection takes place in most occupations; for example, a thin, weedy man would be unlikely to apply for a dock labourer's job, and a boy with little mathematical ability would scarcely seek to be an accountant. What is less obvious is the need for a much better selection for the majority, and the most important mental characteristic to test for is intelligence. It is now possible, within a very narrow margin of error, to test for general intelligence; it is also possible to differentiate between jobs needing intelligence and those needing little. To allow a person of great intelligence to do a job requiring little is wasteful, both to the individual and to the community; to use a person of lower intelligence than the job requires is to reduce output and cause unhappiness to the individual.

Since the War of 1914–18, when the United States produced the group intelligence test, much work has been done. In addition, a better adjustment of the worker to the work can be obtained by testing for various special skills and by systematic training. Experience in such varying trades as silk-weaving, chocolate covering, metal-polishing, folding and calender work in laundries, has shown that by systematizing movements and by training the novice a saving generally results. If a novice is allowed to pick up his job merely by watching proficients, he frequently adopts uncritically many unnecessary movements, which sometimes interfere with his possible speed and in some cases result in muscular habits harmful to him.

Those who are responsible for the teaching of beginners ought to have made a special study both of the technique of the movements and of teaching. Ability to perform an activity is no guarantee of an ability to teach it.

Time and motion study are a necessary part of the scientific study of skilled movement, and both are as necessary in industrial processes as in sport. If they are used merely to 'speed up' regardless of the individual, they are being used illegitimately and will have serious consequences. Any speed that results in a worker feeling flurried stands condemned. It is one of the anomalies of applied psychology that the earliest attempts to study skilled movement were made by two engineers, Taylor and Gilbreth, whose aim in studying the movements was to reduce the waste of human effort and by so doing to reduce the cost of production and enable the worker to earn more.

Suppose, however, that we know the requirements for a particular activity and that we have tests that are scientifically sound and practicable, and that the people in charge are adequate for the work of supervision. We have even then considered only part of the problem, for no account has been taken of temperamental or emotional differences, and the evidence shows that differences of this nature play an important part in many problems of industrial efficiency, sickness absence and labour wastage. In popular speech, 'temperamental' implies some lack of emotional stability. A healthy minded, well-poised person would scarcely be considered to have any temperament, whereas an emotional, erratic, irresponsible person is generally called 'temperamental'. In practical life, we hear more about temperamental failure than temperamental success. This is due to the nature of temperamental failure, which causes suffering, or at least mild discomfort, to those who come in contact with it.

Throughout history there runs a recognition of the importance of the general emotional make-up of individuals, for health, efficiency and happiness. Many observers, chiefly medical men and Fathers of the Church, that is, those whose work brought them into intimate responsible contact with human beings, have recorded as a fact of observation that there are considerable differences of an emotional nature between people, expressed very clearly in their susceptibility to, and behaviour in the face of, sickness and death, and also in their relation to other people, and as long as we have written records we have attempts at classification. The oldest and best-known comes to us from Galen in the second century, namely, the sanguine, the choleric, the phlegmatic and the melancholic. A more quantitative classification is: (1) those who are emotionally well balanced; (2) those whose temperamental organization is adequate for the duties required, but not altogether perfect; (3) those who are somewhat unbalanced, but within the limits of health, for example, persons rather too liable to be afraid or too easily stirred to anger but not thereby prevented from carrying on; their efficiency and happiness may be impaired but not seriously interfered with; (4) those whose temperamental lack of balance interferes with health.

The 'unbalanced' temperament is the so-called 'nervous' temperament. As a mode of behaviour it has been known for centuries, although not by that name. The name was given in the late eighteenth century and has stuck, though it has long since lost any meaning; the name refers to a mistaken belief that the symptoms characteristic of it were related to the organic 'nerves'. There are no tests for the 'nervous' temperament, and its assessment has to be made by a competent interviewer.

On the whole, after an examination of about a thousand people, there was some evidence showing that the nervous person tended to be less efficient in some environments than others, and also to be more difficult to get on with, to be less satisfied with his work and to have a somewhat higher sickness absence rate. Some environments, particularly those characterized by rigidity of organization and an arbitrary personal criterion of efficiency, are difficult for many nervous people.

The incidence of nervous symptoms varies considerably from one group to another. Those with serious maladjustment ranged from 1·2 per cent in a group of factory workers to 7 per cent in a group of clerical workers.

ABSORPTION AND EMISSION OF RADIATION IN THE ATMOSPHERE

THE radiation traversing the atmosphere is in part radiation coming from the sun, and in part radiation emitted by the earth and its atmosphere. The first is mainly in wave-lengths between 0·25 μ and 2·5 μ ($1\ \mu = 10^{-4}$ cm. $= 10^4$ A.): the second is chiefly confined to wave-lengths greater than 5 μ, and may therefore be called long-wave radiation.

The passage of either kind of radiation through the atmosphere is impeded by Rayleigh scattering, by diffuse reflection from cloud particles, and by true absorption: we are concerned here only with the third of these. The major atmospheric gases, diatomic oxygen and nitrogen, do not contribute appreciably to the absorption, which is due to the presence of small quantities of certain polyatomic gases. Of these, the most important are water vapour (which is responsible for the major part of the absorption), carbon dioxide and ozone. Other gases, such as hydrocarbons, nitrogen oxides, cyanogen and sulphuretted hydrogen, may also contribute to the absorption; their total absorption is, however, small.

Ozone is largely confined to the upper atmosphere; if it were concentrated in a horizontal layer at atmospheric pressure at the ground, the thickness of this layer would be only 3 mm. Carbon dioxide, which is fairly uniformly distributed throughout the atmosphere, would form a similar layer about 2 m. thick. Water vapour is largely confined to the lowest few kilometres of the atmosphere. Its amount is very variable: if precipitated on the earth as liquid water, it would form a layer the thickness of which would range from less than 1 mm. on a cold dry day to a few centimetres on a warm, humid day.

Radiation from the sun is absorbed chiefly by ozone in the ultra-violet, between 0·2 μ and 0·3 μ, and in the visible region, between 0·45 μ and 0·65 μ; and by water vapour in the infra-red, especially between 0·8 μ and 2·2 μ. The ozone absorption results in a hot layer in the upper atmosphere, at a height of about 60 km. Apart from its effect in producing this layer, atmospheric absorption of solar radiation is relatively unimportant; with the sun at the zenith it reduces the intensity of the incident radiation only by 6–8 per cent.

Atmospheric absorption of long-wave radiation is much more important. A layer of damp air one metre thick can absorb one tenth of the radiation emitted from the surface of the earth. Successive layers of the same thickness do not increase the absorption proportionately; the atmosphere is fairly opaque in certain wave-lengths, but nearly transparent in others. When the sky is clear, a quarter of the radiation leaving the earth may pass through the atmosphere without being absorbed. The atmosphere returns to the earth radiation of the wave-lengths which it absorbs. Because it is cooler than the earth, it returns rather less radiation than it absorbs; the radiation returned is, say, two thirds of that emitted by the earth. The quantities of radiation absorbed and returned vary very widely, however, with the atmospheric humidity.

The wave-lengths in which the atmosphere absorbs long-wave radiation can be determined by observations of the transmission of infra-red solar radiation through the atmosphere, such as have recently been made by A. Adel and his co-workers[1]. These show water-vapour absorption in a band between 5 μ and 8 μ, the amount of which varies with the humidity; it is nearly complete between, say, 5·6 μ and 7·2 μ. On one wing of this band, at 7·6 μ and 7·8 μ, there is absorption by nitrous oxide (N_2O) and possibly by nitrogen pentoxide (N_2O_5). Between 8 μ and 13 μ there is relative transparency, broken only by an ozone band between 9·1 μ and 10 μ; at its centre this band absorbs rather more than half the sun's radiation. There are weak absorption lines in the rest of the range between 8 μ and 13 μ, due mainly to carbon dioxide and water vapour, but they normally absorb less than 15 per cent of the sun's radiation in this range. A strong band of carbon dioxide absorption begins at about 13 μ, and cuts off the radiation completely by about 14 μ. This band should end at about 17 μ, but no radiation is actually observed beyond 14 μ. This is interpreted as showing that the rotational band of water vapour, which is known to produce large absorption at great wave-lengths, gives virtually complete absorption down as far as 17 μ. The argument is not altogether decisive, since the sun gives very little energy in these wave-lengths, and a small transmission might evade detection. Unfortunately, laboratory data are inadequate to decide whether the radiation beyond 17 μ is likely to be completely cut off by water vapour or not.

The incompleteness of laboratory data on the total absorption of gases in finite ranges of wave-length is a great handicap to workers in this field. Nearly all the experimental results were obtained before 1920. They do not agree with Beer's law, that the intensity of radiation is reduced in the ratio e^{-km} after passing through a column containing m gm. of absorbing material per sq. cm. of cross-section. Actually the total absorption A varies as a complicated function of m and of the pressure p. For air containing small quantities of water vapour or of carbon dioxide $A \propto (mp)^{\frac{1}{2}}$, roughly, for absorptions between 10 per cent and 50 per cent of the incident radiation; for very small absorptions, $A \propto m$; for large absorptions, A increases much more slowly than $m^{\frac{1}{2}}$. These results are explained by the line-structure of the absorption bands, assuming that the absorption coefficient k_ν due to any line varies with the frequency ν approximately, according to Lorentz's collision-damping formula

$$k_\nu = \frac{i\alpha p/\pi}{(\nu-\nu_0)^2 + \alpha^2 p^2}.$$

If absorption is virtually complete at the line-centres, but line-wings do not appreciably overlap, this gives $A \propto (mp)^{\frac{1}{2}}$; if line-wings overlap, A increases more slowly than $(mp)^{\frac{1}{2}}$; if absorption is fairly small, even at the line-centres, we get $A \propto m$.

The line-width $2\alpha p$ is in general larger when due to collisions with like molecules than when due to collisions with unlike. Thus steam gives greater line-absorptions than air containing the same amount of water-vapour. Steam also gives wider absorption bands than damp air. Absorption at the wings of the bands is by molecules with large rotational energies, and the number of such molecules increases rapidly with increasing temperature. Thus, for example, in the range 11–25 μ, steam absorption is far greater than that of damp air, especially at the short-wave end of the range. This means that the difficulties inherent in the measurement of the absorption of long columns of damp air cannot be avoided by concentrating the water vapour into short columns of steam. Unfortunately, many of the experiments on water vapour absorption were made with steam.

The most complete set of measures with long atmospheric columns is that of Fowle[2], in which absorbing paths up to 200 m. in length were used. Fowle's measures were made with a rock-salt prism, and so are limited to wave-lengths less than 15 μ. Within this range his results agree roughly with those of Adel, quoted above, except, of course, that they did not reveal ozone absorption, which takes place in the upper atmosphere.

Beyond 15 μ, experimental data are scanty. To fill the gap, W. M. Elsasser[3] has recently attempted to calculate the absorption of water vapour from the observed positions and calculated intensities of the absorption lines, between 18 μ and 130 μ. Elsasser uses Lorentz's formula, quoted above, and determines the absorption A in the range in which $A \propto (mp)^{\frac{1}{2}}$. His estimates are subject to several causes of error, and one of his main conclusions, that line absorption is not large at wave-lengths below about 22 μ, is directly contradicted by the observations of Adel and others[4]. Nevertheless, his method is both interesting and suggestive.

Elsasser also predicted, on the basis of Lorentz's formula, that the wings of strong absorption lines near 50 μ would produce a continuous absorption in the region 10–15 μ. Adel obtained results agreeing with this prediction; but Strong[4] has recently set out evidence suggesting that what Adel observed was not a genuine continuous absorption, but a smoothed line absorption. There is no other evidence, experimental or theoretical, that Lorentz's formula is valid as far from the line-centre as Elsasser demands.

The above may serve to indicate how greatly workers on atmospheric radiation are handicapped by the inadequacy of laboratory data on absorption by water vapour. The absorption of carbon dioxide is more easily studied, since a mass of atmospheric carbon dioxide has nearly the same effect as an equal mass of the pure gas at the same pressure and temperature. Ozone absorption has not often been studied, and little is known about its variation with pressure and temperature—an unfortunate fact, in view of the great heights at which ozone absorbs.

Meteorologists have recently attempted to fill the gaps in the laboratory data by measurements on total atmospheric absorption and emission of radiation, summed over all wave-lengths[5,6]. A source of black radiation is viewed through an air column of variable length; the radiation received differs from that leaving the source because of absorption and emission in the air column. If the source is so cold that its radiation is negligible, the emission of the air is directly measurable; this known, the absorption of radiation from sources at other temperatures can be found. The percentage absorption depends on the temperatures T_s, T_a of both source and air; it increases as T_a increases, but decreases as T_s increases, because of the increased importance of shorter wave-lengths, where water vapour absorption is smaller. The emission is equal to the absorption when $T_s=T_a$; considered as a fraction of the black-body emission at the same temperature, it decreases slowly as T_a increases. The results for long absorbing columns do not suggest that there can be any great transparency of water vapour beyond $17\,\mu$.

Brooks[6] has recently indicated how such measures can be used as the basis for a study of atmospheric radiation. He has to ignore the variation of the percentage absorption and emission with T_s and T_a, and to assume that the quantities of water vapour, carbon dioxide and ozone in the atmosphere bear a constant ratio to each other. In theory, it is far better to consider the radiation in the separate wave-lengths; but because of the inadequacy of experimental data, Brooks's method has much to recommend it.

Another question, which has been studied for many years, is that of the total radiation reaching the earth from the atmosphere from all directions and in all wave-lengths. This is most easily studied at night, and is therefore usually called the nocturnal radiation of the atmosphere; it can, however, also be studied during the daytime. The radiation depends markedly on the ground temperature T and the vapour pressure e at the ground. Brunt has found that at any place it is given roughly by $\sigma T^4(a+b\sqrt{e})$, where σT^4 is the black-body emission at temperature T, and a, b are constants the values of which differ, however, from place to place. Brunt suggests that the variation in a and b may be due to differences in the instruments used by different observers; but part may well be due to differences of pressure of the temperature- and humidity-gradients, and of ozone emission.

Strong[4] has interpreted the factor $a+b\sqrt{e}$ in Brunt's expression as follows. At certain wave-lengths, air radiation is due to the emission of carbon dioxide and ozone, and does not vary with e; at others, water vapour is so opaque that it emits like a black body of temperature T, whatever e. Such wave-lengths contribute the term a. At yet other wave-lengths, water-vapour absorption is small and obeys the square-root law (in our earlier notation, $A \propto (mp)^{\frac{1}{2}}$). These contribute the term $b\sqrt{e}$. The explanation is suggestive, but incomplete, since there are wave-lengths in which water vapour is not opaque, but its absorption is too large to obey the square-root law, and these wave-lengths vary somewhat with the zenith distance and the humidity. The factor σT^4 in Brunt's expression also needs explanation, both since the temperature of the emitting air may differ somewhat from T, and because the emission in the wave-lengths at which the atmosphere is opaque need not follow the T^4 law characteristic of a black body emitting all wave-lengths.

Besides depending on T and e, the nocturnal radiation of the atmosphere must vary with the ozone content of the upper atmosphere. The ozone band between $9{\cdot}1\,\mu$ and $10\,\mu$ comes in a range of wave-lengths where the atmosphere is otherwise nearly transparent, and so emission in this band at high levels appreciably affects the radiation reaching the ground. Conversely, radiation leaving the ground is able directly to influence the temperature of the stratosphere because of ozone absorption. Since it receives radiation direct from the ground, ozone tends to produce a higher stratospheric temperature than water vapour and carbon dioxide, which receive radiation from the cold upper troposphere. The effect of the ozone absorption is the more considerable because there is little water vapour at great heights. For this reason, Dobson has suggested recently[7] that stratospheric temperatures may be largely influenced by ozone absorption. His suggestion makes the temperature of the stratosphere depend on the relative amounts of ozone and water vapour present, and explains qualitatively the high stratospheric temperature at the poles, and the advance in phase of the annual variation of temperature in the stratosphere relative to that at any lower level.

[1] Adel, A., *et al.*, *Phys. Rev.*, **47**, 580 (1935); **49**, 288 (1936); also a series of papers in *Astrophys. J.*, beginning in vols. 84 and 87.

[2] Fowle, F. E., *Smithson. Misc. Coll.*, **68**, No. 8 (1917).

[3] Elsasser, W. M., *Astrophys. J.*, **87**, 496 (1938); *Phys. Rev.*, **53**, 76 (1938).

[4] Strong, J., *J. Franklin Inst.*, **232**, 1 (1941).

[5] Falckenberg, G., *Met. Z.*, **53**, 172 (1936); **55**, 174 (1938); and **56** 72 (1939). Elsasser, W. M., *Mon. Weath. Rev.*, **69**, 1 (1941).

[6] Brooks, F. A., *Mass. Inst. Tech. Papers in Phys. Oceanography and Meteorology*, **8**, No. 2 (1941).

[7] Dobson, G. M. B., at a joint meeting of the Royal Meteorological Society and the Physical Society, held on May 20.

OBITUARIES

Dr. C. D. Sherborn

THE sudden death of Charles Davies Sherborn on June 22, within a week of his eighty-first birthday, came as a shock to his many friends. The staff and other workers at the British Museum (Natural History), with which he was continually associated since 1886, will mourn the loss of a distinguished and much-loved colleague, and will sadly miss the inspiration of an outstanding personality.

Born in Chelsea, he was the eldest son of Charles William Sherborn, the celebrated line-engraver and etcher. He received some of his early schooling at the hands of Miss Elizabeth Rye, then a noted educationist, and afterwards went to St. Mark's College School, Chelsea. At the age of fifteen he went into business, first with a bookseller and stationer, and later with a tailor. Then abandoning business for a scientific career, he set off for Switzerland and Germany, and during 1886–87 studied at the University of Strasburg.

At this period of his life Sherborn seems to have been first attracted to the study of geology and palæontology, and worked with Thomas Rupert Jones on the Foraminifera and Ostracoda. His "Bibliography of the Foraminifera" (1888), and his "Index to the Genera and Species of Foraminifera" (1896), indicate the first approaches to what was to become the ruling passion of his life. In 1890, in collaboration with Sir Arthur Smith Woodward, he published "A Catalogue of British Fossil Vertebrata", and at about the same time he catalogued the collections and library of the Geological Society of London, from which body he received the Lyell Fund in 1890. From 1892 until 1899 he was a member of the editorial board of *Natural Science*, and during this period prepared a new edition of a catalogue of the library of the Linnean Society of London. He was invited to examine and arrange the letters and papers of Sir Richard Owen at Sheen Lodge, and assisted in the preparation of the scientific part of Richard Owen's life of his grandfather (1894). Between 1894 and 1908 he undertook a survey of the "White Chalk of the English Coast", in conjunction with the late Dr. A. W. Rowe, and surveyed western Cornwall with Upfield Green. The Geologists' Association, of which he was honorary secretary for nine years, published the results of the chalk survey.

Inspired by the projected "Index Kewensis" for plants, Sherborn put forward in 1890 a scheme for an "Index Animalium", designed to provide a complete list of all generic and trivial names from 1758 to 1850, with a reference to the date and place of publication of each name. This stupendous task, involving the extraction of more than 415,000 references from the original sources, proceeded steadily, and, in spite of a serious breakdown in Sherborn's health during the early stages, the first volume (1758–1800) appeared in 1902. The ten volumes comprising the second section (1800–1850) were published under the auspices of the British Museum (Natural History), and the final part did not appear until 1933—forty-three years after the inception of his self-imposed task!

Sherborn's published papers, many of them of a bibliographical nature, number nearly two hundred, commencing with one on Jurassic fossils in 1886 and ending with his extremely useful booklet "Where is the —— Collection?" in 1940. In addition, his bibliographical work led him to amass copious notes in manuscript, which have been consulted at the Museum by numerous workers and proved invaluable when a catalogue of the Museum's library was prepared by the late B. B. Woodward. He found time to investigate the history of his own family, a labour of love which resulted in "A History of the Family of Sherborn" (1901) and "A Sketch of the Life of Charles William Sherborn" (1912).

Sherborn was an honorary fellow of the Zoological Society of London, and served on the Publication and Finance Committees for many years; an associate of the Linnean Society of London; president of the Society for the Bibliography of Natural History; and an honorary life fellow of the Metropolitan Museum of New York. In 1931 the University of Oxford conferred upon him the honorary degree of doctor of science—a fitting recognition of his life's work.

Such, in brief outline, was the professional career of a man whose liberal culture and diversity of interest and activity were a constant surprise even to those who knew him well. Possessed of a very modest income, and living what to others appeared a most spartan life, he was able to indulge his passion for collecting stamps, coins, books, manuscripts, prints, and antiquities of all kinds. His valuable series of Byzantine coins, on which he was a recognized authority, was presented shortly before his death to the Fitzwilliam Museum, Cambridge, and his prints to the Art Department of University College, London. His many donations to both branches of the British Museum and to other institutions, together with his generous gifts to colleagues and friends, provided a practical expression of one of his most cherished convictions—that objects of special interest or value should ultimately rest in the hands of those who would best appreciate them.

Of the many qualities that endeared him to all, his kindliness, toleration, ready wit and equable temper, and, above all, his abundant generosity, stand out, and few who were admitted to friendship with "The Squire" can have failed to benefit by the association. His ready hospitality to foreign visitors and to other lonely folk provides but one example of his thought for others, and an invitation to "smoke and chat" at his house gave promise of an entertaining and instructive evening. His alleged dislike of women was probably a pose, and those wives of his friends who were lucky enough to gain his friendship soon discovered the kindly and sensitive nature beneath the cloak of gruff misogynism. He was unmarried, and is survived by two brothers.

J. R. NORMAN.

Mr. R. G. McConnell

RICHARD GEORGE MCCONNELL died in Ottawa. Canada, on April 1, 1942, in his eighty-sixth year. His death removed one of the last of Canada's outstanding geological explorers. He was born in Chatham, Quebec, on March 26, 1857, received his B.A. degree from McGill University in 1879 with first-class honours in natural sciences and in 1880 began geological exploration for the Geological Survey of Canada. His first work with the Geological Survey was done in Quebec province, but during 1881–1914 he was engaged every summer in geological studies mainly of reconnaissance and exploratory nature in the west and north-west of Canada. In 1914, he was appointed Deputy Minister of Mines, which position he held until his retirement from the Department in 1921. For several years thereafter he carried on consulting geological work and spent two summers on geological work for the Ontario Department of Mines.

McConnell's field work in the west as an officer of the Geological Survey covered a tremendous area. For five years he dealt with southern Alberta and Saskatchewan, providing much new information on the stratigraphy and coal areas. For three years he studied and mapped the Rocky Mountains west of Calgary, and was the first to recognize and interpret the great thrust faults along the mountain front. For four years he carried on geological mapping in the highly metalliferous West Kootenay area in British Columbia. For a ten-year period his work lay in Yukon, where among many important contributions may be mentioned his study of the Whitehorse copper belt, the Klondike placer field and his persistent recommendations for dredging which were later carried out with considerable profit. For eight years he worked in various parts of British Columbia, dealing mainly with the Portland Canal district, Texada Island, Finlay and Omenica Rivers and Rainy Hollow. For two years he covered ground north of Lesser Slave Lake, including the Athabaska tar sand area. For one winter he remained in the far north, and during the preceding and following field seasons made one of the longest and most remarkable Canadian exploratory trips when he travelled from Wrangell via Telegraph Creek, Dease River and Liard River to the delta of the Mackenzie, returning by way of Porcupine and Yukon Rivers to Skagway. As a result of this trip down through the Grand Canyon of the Liard he was the first explorer to recognize the fact that the Rocky Mountain system ended at latitude 60° N. The results of his field work were published on many geological maps and in some forty reports of the Geological Survey.

McConnell was a fellow of the Royal Society of Canada; he was elected in 1913 and president of Section 4 in 1918. He was elected a fellow of the Geological Society of America in 1889. He became a member of the Canadian Institute of Mining and Metallurgy in 1898. He was also an honorary member of the National Geographic Society.

In November 1898 he married Jean T. Botterell of Montreal. His wife predeceased him by three years. He is survived by a son, Richard, on active service in Africa, and a daughter, Winifred.

He did not seek reward or high position; his ambition was to do the appointed task as well as possible and to further the science of geology. In order to be prepared for any work that he might be called upon to do, he kept himself in excellent physical condition by taking long walks. He took hardships as a matter of course, but nevertheless he could tell interesting stories about them afterwards when surrounded by personal friends, though he invariably declined to tell of his work or experiences on a public platform. After his return from an expedition he would immediately write his account of it in excellent English, and for the rest of the winter or spring would study reports of other geologists to keep up to date in his chosen field. He was fond of the outdoor life, and his keen powers of observation made him an outstanding field geologist. He loved the hills and was reluctant to give up his summer explorations to take on office duties as Deputy Minister. His body was cremated in Montreal and the ashes were scattered over the country he loved so much.

GEORGE HANSON.

Major G. W. Dunkin

MAJOR G. W. DUNKIN, lately director of the Agricultural Research Council Field Station, Compton, Berks, died on March 21 of this year. After postgraduate study, taking the diploma of veterinary hygiene of the University of Liverpool, he settled in general veterinary practice in Kent. Three or four years later, on the outbreak of war in 1914, he joined the Royal Army Veterinary Corps and spent most of his war service in Egypt, latterly commanding the 20th Veterinary Hospital in that country. He returned to practice after the War, but in 1923 was appointed superintendent of the Farm Laboratories Medical Research Council, Mill Hill.

From then on he carried out much important research on animal disease problems, and in this sphere his keen and inquiring mind and his early training and experience enabled him to plan and execute intricate large-scale experiments with domesticated animals and bring these to successful conclusions, avoiding much of the incidental, often unforeseen, complication that can delay and spoil such work on occasion.

Undoubtedly Dunkin's name will be remembered in future more particularly in connexion with the successful investigation into the causation of distemper in dogs carried out in collaboration with the late Sir Patrick Laidlaw. This is a classic in epidemic disease research. Among diseases to which Dunkin devoted much time are Johne's disease of cattle and bovine contagious abortion. He spent years on the study of Johne's disease, particularly with a view to the elaboration of a reliable diagnostic agent and to the production of a vaccine. He obtained important results, and though the problems have not been solved his contributions will be remembered.

In 1937 Dunkin was appointed to the Compton post and the intervening years were devoted to the organization of the estate to suit the requirements of the Agricultural Research Council, and to the inauguration of a large-scale research scheme on bovine contagious abortion.

Major Dunkin was a very active man in many spheres. He had held high office in the National Veterinary Medical Association of Great Britain and Ireland and on the Council of the Royal College of Veterinary Surgeons. He was chairman of the examination committee of that body. He was chairman for some years of the editorial committee of the National Veterinary Medical Association and chairman of a special committee of the Association to investigate small animal euthanasia, an important report being published under his guidance. He held the office of president, Section of Comparative Medicine, Royal Society of Medicine.

NEWS and VIEWS

Sir Henry Tizard, K.C.B., F.R.S.

BY electing Sir Henry Tizard as their president, the Fellows of Magdalen College, Oxford, have made a timely and important break with Oxford tradition, for he is the first man of science to become a head of a college there. When the country can spare him from his present extremely important duties as a member of the Air Council and of the Advisory Council of the Ministry of Aircraft Production, he will return to his old college with a mind enriched by an exceptionally wide and varied experience in the arts of war and peace. He won his spurs in scientific research under the guidance of Prof. Townsend, and his valuable work with Dr. Pye on adiabatic compression of gases made a link with internal combustion engineering which he has maintained ever since. The War of 1914–18 turned his thoughts and efforts to aeronautical research, and he has long exerted a highly important directing influence on British aircraft development, and on the solution of the problems of air warfare, offensive and defensive; these services have stood the nation in good stead during the present great struggle for a free world. The guidance of State assistance to research in pure science and in industry occupied him for eight years between the two Wars, and from that he turned to the administration of scientific and technical education, as rector of the Imperial College of Science and Technology, which has greatly prospered under his leadership. At Oxford, as in London, it is certain that he will not only be successful as head of his College, but also take a prominent part in science, education and national affairs.

Dr. W. S. Gordon

IN the obituary notices in this issue reference is made to the work of the late Major G. W. Dunkin, who was director for the past five years of the Compton Field Station of the Agricultural Research Council. Dr. W. S. Gordon, senior bacteriologist, Animal Diseases Research Association, Moredun Institute, Gilmerton, Edinburgh, has been appointed to succeed Major Dunkin. A graduate of the Glasgow Veterinary College in 1923, Dr. Gordon was on the staff of the Wellcome Physiological Research Laboratories, Beckenham, for some years and took up the Scottish appointment in 1930. At Beckenham he was associated with Prof. Dalling, and other workers in those laboratories, in the production of biological products, and particularly in investigations of anaerobic infections in sheep. In Scotland he has led a team of workers in investigating and dealing with certain sheep diseases, notably louping-ill, tick-borne fever, braxy and lamb dysentery.

At the time of Gordon's appointment, the causal agent of louping-ill had just been discovered at the Edinburgh institute. Dr. Gordon followed up this work, making a close study of the disease and of the filtrable virus responsible for it, and developed methods for the immunization of sheep against the infection. An early discovery in this later work was that two entirely different virus infections were associated with louping-ill, that due to the true louping-ill virus and another, hitherto not recognized, that was named the virus of tick-borne fever, the latter infection being in itself a less severe disease. Among other disease problems on which he has worked in Scotland is grass sickness in horses, and although the cause of the disease is still unknown he has made notable contributions to the literature on the subject. Dr. Gordon has been active in a wide range of veterinary activities in Scotland and has a close personal interest in, and a practical experience of, general farming.

Dr. W. E. Gaunt

DR. W. E. GAUNT has been appointed research director of the Ashe group of associated companies. Dr. Gaunt graduated from the Colour Chemistry Department at the University of Leeds and obtained his Ph.D. for work on biochemistry and physiology undertaken at the Leeds School of Medicine. Afterwards Dr. Gaunt joined Sir John Orr's staff at the Rowett Research Institute to work on nutrition problems, and just before the War went to Guy's Hospital Medical School as dental research fellow to do work of a similar nature. Since the War started Dr. Gaunt has gained further experience in organic chemistry at Guy's, working with Prof. C. S. Gibson, and has also increased his all-round knowledge of nutrition during a short spell with Imperial Chemical Industries Ltd. Dr. Gaunt's experience in several research fields will enable him to serve Messrs. Ashe Laboratories Ltd. in maintaining and extending on sound nutrition lines their numerous food products. We understand that Dr. Gaunt will be encouraged to continue work on fundamental problems, particularly on human protein requirements.

Newton as an Astrophysicist

A PAPER by Elizabeth Connor entitled "Sir Isaac Newton, the Pioneer of Astrophysics" appears as Leaflet No. 158 of the Astronomical Society of the Pacific (April 1942), which supplies a brief outline of the life and work of Newton. Up to the time of entering the University of Cambridge, Newton had not exhibited any extraordinary talent, and though his undergraduate days were profitable, those which followed immediately after he graduated were the most productive which any scientific worker ever experienced. The outbreak of the plague forced him to leave Cambridge, and practically all his time between August 1665 and March 1667 was spent at Woolsthorpe, where his exile allowed him to concentrate on some of his greatest achievements. Among these may be noticed his method of fluxions, the law of the composition of light, and the law of universal gravitation. During this period he gave attention to experiments with the refracting telescope, but because he believed that chromatic and spherical aberration could not be overcome, he turned his attention to the reflecting type.

Towards the end of 1668 Newton completed his first telescope with an aperture of a little more than an inch and a tube 6 in. long. His second telescope was exhibited at the Royal Society in 1672 and is still in the possession of the Society. Its principle was used as the model and forerunner of a succession of giant telescopes which have been constructed since the days of Newton and are still the astrophysicist's best tool. His "Principia" did not appear until 1687 and his real scientific career ended with its completion. Most of his later years were spent in London as Master of the Mint, and he had many honours bestowed on him, but there was no return of the originality of his earlier days. Nevertheless, he gave a considerable amount of time to working over the material in hand. In 1704 his "Optics" appeared and in 1713 and 1726 the second and third editions of the "Principia". Specialists in various branches of science still voice the debt of their sciences to Newton.

Benedict Dybowski

AMONG the Poles whose scientific work was conducted in and for Russia was Benedict Dybowski, a sketch of whose life is given by Dr. J. Borucki in the first issue of *Polish Science and Learning* (June, 1942: Oxford University Press. 2*s*. 6d.). Dybowski was born at Minsk in 1833. As a schoolboy he kept various animals and was apparently the first to observe the metamorphosis of Petromyzon. He studied medicine and biology at Dorpat (1856), Breslau (1857) and Berlin (1860), where he published minor researches, for example, on artificial insemination of bees. At Dorpat again, in 1861, he worked on a monograph of the fishes of the Baltic lands. However, he was arrested for his political beliefs, and though the sentence of deportation was at first revoked, he was sent to Siberia after the 1863 insurrection. Here he began by exploring the forest and steppe around Czyta. Later, at Kultuk, he made long journeys to the Saya Mountains and to Chamar, developing a vast philanthropic medical service among the native population, so that the governor, J. G. Skolkow, invited him to join an expedition to the tributaries of the Amur and Ussuri Rivers, penetrating as far as the Pacific. They had scanty means, having to make their own boats. Nevertheless, Dybowski sent extensive collections to European museums and developed a view that each region showed a special structure of animal life in close correspondence with the environment. He discovered a number of hitherto unrecorded species, including a deer on the Ussuri, and noted the differences between Siberian and Bengal tigers. The birds he collected provided the basis for Taczanowski's critical "Review of Siberian Ornithological Fauna".

With Godlewski, Dybowski spent several years studying the fauna of Lake Baikal, and his researches included biological, chemical, bathymetric and temperature observations. The molluscs and sponges collected at this time were later described in a classical monograph by Benedict's brother, Wladislaw. Dybowski's extensive researches had enabled his friends to secure his release in 1876, but he continued his medical, scientific and humanitarian work in east Siberia. Here he bought horses and reindeer for starving natives and introduced rabbit and goat-breeding into Kamchatka to give the native population a surer livelihood. The last years of his life brought him many honours from his native Poland, for he lived until 1931, dying in his ninety-ninth year. His earnest wish for good relations between the Slav peoples was not realized in his life-time, but his work in this connexion may inspire others to work for the same ideal now that there is close collaboration between Poland, the U.S.S.R. and Czechoslovakia in the many common aims that link them with other lands in the struggle for liberty.

Infant Protection in Mexico

IN an article on this subject in the May issue of the *Boletín de la Oficina Sanitaria Panamericana*, Dr. Salvador Zubirán, Under-Secretary of Public Assistance, states that Mexico is trying to reduce its high infant mortality, which was 30·5 per 1,000 births in 1905 and 122·7 in 1939, by the establishment of child welfare centres which were opened in 1929. In 1937 they were placed under a single Government department, and child welfare became a social as well as a medical obligation of the Government, and lost its 'charity' implications. Important objectives include the integration of the home, establishment of foster homes for deserted children, adoption of orphans, pre-natal training for the mother, vocational training for her if she has to work, and aid from pregnancy until the child is six years old. A children's hospital is being opened in Mexico this year to serve as a centre for medico-social education, scientific investigation and the spread of pædiatric information.

Anthropology in Switzerland

THE *Bulletin der Schweizerischen Gesellschaft für Anthropologie und Ethnologie*, 1941–42, contains a list of members of the Society, a report of meetings held during 1941, and three original articles. Dr. Hans Dietschy advances a number of theories to account for and to explain the attributes and nature of the Aztec pantheon. Dr. Lucia Graf describes some late medieval skeletal remains which were excavated from Holderbank in the Solothurn Canton in 1940, and Prof. Otto Schlaginhaufen provides a very complete anatomical and anthropometric description of four skeletons from Darvela near Truns. Late Iron Age (la Tène period) material was found with these bones. The cranial indexes of the skulls were respectively 76·1 and 74·5 for two male specimens, and 79·4 and 82·8 for two female skulls.

Committee on Synthetic Rubber

SIR ANDREW DUNCAN announced in the House of Commons on July 22 the formation of a Committee to consider the question of synthetic rubber to be constituted as follows: Mr. F. W. Bain, chairman of the Chemical Control Board of the Ministry of Supply (chairman); Sir Edward V. Appleton, secretary of the Department of Scientific and Industrial Research; Dr. J. W. Armit, director-general of explosives at the Ministry of Supply; Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford; and Dr. F. Roffey, controller of chemical research at the Ministry of Supply.

Earthquake Registered at Kew

ON July 12, a strong earthquake was registered on the seismographs at Kew Observatory. It began recording with *iP* compressional on all three components at 05h. 17m. 47s. U.T. From a tentative interpretation, the *eS* wave registered on all three components (north-south, east-west and vertical) at 05h. 28m. 09s. U.T., which gives the epicentral distance according to the tables in use at Kew as 9,230 km. A full suite of pulses was registered, the maximum ground movement at Kew being 29 μ amplitude at 05h. 53m. 15s. U.T. on the vertical component. The earthquake finished recording at 09h. 05m. U.T.

Announcements

LORD LOUIS MOUNTBATTEN, who is a vice-president of the Institution of Radio Engineers, has given a prize to the Institution, to be known as the Mountbatten Medal; it will be "awarded to the candidate who has proved himself the best candidate amongst those of the Royal Navy or Air Force who have presented themselves for the Graduateship Examinations of the Institution held during the year".

THE British Museum (Natural History), Cromwell Road, South Kensington, London, will re-open to the public on August 1. Owing to shortage of staff and the evacuation of many exhibits, it is possible to open at present only very few of the galleries. The times of opening will be 10–4 on weekdays and 2–4 on Sundays. Small children must be accompanied by an adult or a responsible older child.

THE trustees of the Leverhulme Research Fellowships have approved the following awards for research, tenable for varying periods up to two years: Dr. M. R. Anand, for work on landmarks in Urdu literature; Dr. R. S. Bagnall, for a monograph of the British Apterygota, including springtails, bristle-tails, and other primitive groups; Miss A. M. Cameron, warden, Lady Margaret Hall Settlement, Lambeth, for the study of voluntary social service by wage earners.

WRITING with reference to the review entitled "A Fateful Legacy" in NATURE of July 18, p. 72, Prof. Macgregor Skene points out that the complete quotation from Darwin's "Origin of Species", and indeed the last sentence of the book, is: "There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

REFERRING to the obituary of Sir Daniel Hall in NATURE of July 25, Mr. G. M. Johnson, head master, states that the school in which Sir Daniel Hall was so long interested, and in which he did such good work as chairman of the governors, is The Lord Wandsworth College, Long Sutton, Basingstoke, Hants, and not as stated in the obituary notice, at Wantage. Sir Daniel Hall was taking an active part in the life of the College until he entered the nursing home in London, some three weeks before his death.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Distribution of Attack on Iron or Zinc Partly Immersed in Chloride Solutions

IRON or zinc partially immersed in sodium or potassium chloride at first remains unattacked at the water-line. Corrosion occurs at a zone somewhat below the water-line, and researches at Cambridge[1] have indicated it to be connected with the electric current flowing between this zone as anode and a cathodic zone at the water-line, where oxygen, the cathodic stimulator, can most easily be renewed. The corrosion rate has been found to be approximately equivalent, in the sense of Faraday's Law, to this current, which, for solutions of high conductivity, may approach the limiting value given by the interection of the anodic and cathodic polarization curves; for less conducting liquids, it is that value i, which will make an intercept iR, where R is the resistance. Thus the short-period phenomena have been fairly well cleared up. However, the long-period corrosion researches of Bengough and Wormwell[2] at Teddington have shown that finally both metals became more attacked at the water-line than anywhere else. The violent attack at the zone previously immune tended o suggest that the mechanism of corrosion in the later stages was different from that in the early stages; but by introducing the essential distinction between probability and conditional velocity[3], a common explanation appears for the seemingly divergent facts.

If the probability that corrosion will commence at a given point within a time element dt be defined as $p\,dt$, the chance that the point will escape corrosion for time t and then commence to corrode in dt will be $e^{-pt}p\,dt$. The 'expected' corrosion over an experiment asting time T will be

$$\int_0^T e^{-pt}\,pu\,(T-t)\,dt, \quad \text{or} \quad uT - \frac{u}{p}\,(1 - e^{-pT}),$$

where u is the conditional velocity (mass per unit ime and area). This approaches the limiting values of $\frac{1}{2}upT^2$ and uT, as T approaches zero and infinity espectively.

Now p will be minimal at the water-line, since the cathodic product (sodium or potassium hydroxide) is a powerful inhibitor; on the other hand, u will be maximal at the water-line, although it will vary little with level, unless the 'intercept-correction', referred to above, is considerable. Numerous measurements of potential at different distances from the water-line have indicated[4] that the intercept-correction is small, except in very dilute solution; we may expect, therefore, that u will be maximal at the water-line, but that its variation with level will be much less than that of p. Consequently, in the early stages where u and p enter symmetrically into the expression $\frac{1}{2}upT^2$, the expected corrosion will in effect be least where p is lowest, thus explaining the immunity at the water-line. In the later stages, where p does not enter into the expression (uT), the expected corrosion will be greatest at the water-line, where u is highest. Thus we arrive at an explanation of the apparently discordant facts that *the water-line s unattacked in the early stages and severely attacked in the later stages.*

Other possible causes for the severe water-line attack in the advanced stages may deserve consideration, but for the moment the mechanism suggested seems capable of explaining the known facts. The argument just sketched has, however, neglected the possibility that the value of p or u may be shifted by previous occurrences at the same point, or by simultaneous occurrences at neighbouring points. The accumulation of alkali at the water-line (if not dissipated by stirring or by conversion to carbonate) may cause p to fall with the time, thus postponing, perhaps indefinitely, the breakdown at the water-line. Experiments by Dr. T. P. Hoar and by Dr. R. S. Thornhill at Cambridge, largely unpublished, have shown that, if such disturbances be avoided, the water-line will remain immune for long periods (60–90 days). Zinc is more liable to attack at the water-line than iron, while wetting of the specimen above the water-line is found to increase the chance of breakdown, as would, of course, be expected.

ULICK R. EVANS.

Metallurgical Laboratories,
University, Cambridge.

July 16.

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[1] Evans, U. R., *J. Inst. Met.*, **30**, 257 (1923); Evans, U. R., and Hoar, T. P., *Proc. Roy. Soc.*, A, **137**, 343 (1932); Agar, J. N., unpublished work summarized by Evans, U. R., *J. Iron Steel Inst.*, **141**, 221P (1940).

[2] Bengough, G. D., and Wormwell, F., *Proc. Roy. Soc.*, A, **140**, 402 (1933); *Chem. Ind.*, 262 (1936).

[3] Evans, U. R., Mears, R. B., and Queneau, P., *Engineering*, **136**, 689 (1933); Evans, U. R., and Mears, R. B., *Proc. Roy. Soc.*, A, **146**, 164 (1934); *Trans. Faraday Soc.*, **31**, 530 (1935).

[4] Evans, U. R., Bannister, L. C., and Britton, S. C., *Proc. Roy. Soc.*, A, **131**, 366 (1931); Evans, U. R., and Hoar, T. P., *Proc. Roy. Soc.*, A, **137**, 358 (1932).

Determination of Absolute from Relative X-Ray Intensity Data

IN the 'absolute measurements' of X-ray intensities of reflexions from a crystal, a measurement must be made of the monochromatic radiation incident upon the crystal in one second[1], which, though it can be done fairly conveniently by the ionization chamber method[2], requires a complicated design of apparatus in the use of the rotation photographic method. I have considered the problem in the light of a new synthesis of X-ray data[3] and found that the absolute values of $|F(h)|^2$ may be deduced to a close approximation from the relative intensity data without any further experimental work. The derivation of the equations needed in this deduction in the case of a linear crystal is shown below.

We first assume the relative intensities are known, deduced, in the case of the photographic methods, from the total blackening of the reflexion lines or spots registered on a photographic film. We then assume that corrections are made to these observed data for the various geometrical factors such as the polarization factor, the Lorentz factor, planar factor, and so on. We further assume that we have corrected for the temperature factor. (This assumption is in general not exactly true of course.) The final result is a set of numerical values $H(h)$ which are linearly related to $|F(h)|^2$ by $H(h) = c\,|F(h)|^2$, where c is the constant multiplying factor we intend to determine. For the moment we assume c is known. Then according to Y. L. equation (5) [the notation stands for equation (5) in Yü's letter[3]] we have, $E(h) = \frac{H(h)}{2c\psi(j)^2}$.

If we denote $\frac{H(h)}{\psi(j)^2}$ by K_h for $h \neq 0$ then $E_h = \frac{K_h}{c}$.

We further have $E_0 = \frac{1}{2}\,|F(0)|^2 = \frac{1}{2}\left|\sum_{a=1}^{s} Z_a\right|^2$ (E_0 here and E_h above as well as all the other symbols not defined in this letter have the same significance as in Y.L.). Now let us combine Y.L. equation (2) and equation (4) and substitute the values of E_h and E_0 given above in the resultant equation; we then obtain

$$E(q) = \frac{1}{2}\left|\sum_{a=1}^{s} Z_a\right|^2 \sum_{\mu=0}^{N/2} a_{\mu_0} \cos 2\pi q u_\mu + \sum_{\mu=0}^{N/2} \sum_{h=1}^{\infty} a_{\mu h} \frac{K_h}{c} \cos 2\pi q u_\mu,$$

where $u_\mu = \frac{\mu}{N}$. If in the equation we replace q by an integer k and substitute $E(k)$ by $\frac{K_k}{2c}$, we have, after a transformation of terms, that,

$$c = \frac{K_k - 2 \sum_{\mu=0}^{N/2} \sum_{h=1}^{\infty} a_{\mu h} K_h \cos 2\pi k u_\mu}{\left|\sum_{a=1}^{s} Z_a\right|^2 \sum_{\mu=0}^{N/2} a_{\mu_0} \cos 2\pi k u_\mu}.$$

When $k = 0$, we have,

$$c = \frac{2 \sum_{\mu=0}^{N/2} \sum_{h=1}^{\infty} a_{\mu h} K_h}{\left|\sum_{a=1}^{s} Z_a\right|^2 \left\{1 - \sum_{\mu=0}^{N/2} a_{\mu_0}\right\}}.$$

Since all the quantities on the right-hand side of the last two equations are known, c can be calculated by either of the equations. Consequently the absolute values of $E(h)$ and so of $|F(h)|^2$ are determined. The method might be an approximate one in general due to the approximation involved in Y.L. equation (5). Accordingly, if the absolute values of $|F(h)|^2$ are determined by the existing experimental methods, the present method would provide a test of the approximation involved in Y.L. equation (5) for the crystal in question.

S. H. YÜ.

Metals Research Institute,
National Tsing-Hua University,
Kunming, Yunnan. April 14.

[1] Bragg, W. L., "The Crystalline State", 1, 219.

[2] Compton, A. H., *Phys. Rev.*, 9, 29 (1917).

[3] Yü, NATURE, 149, 638 (1942).

Yü's letter[1] on the determination of absolute from relative X-ray intensities suggests several interesting possibilities. His equations might be useful to anyone working with his synthesis[2], but it is possible to devise a method not depending on the quantities $\alpha_{\mu h}$, which are not yet available. The ideal intensity of the *hkl* reflexion is given by

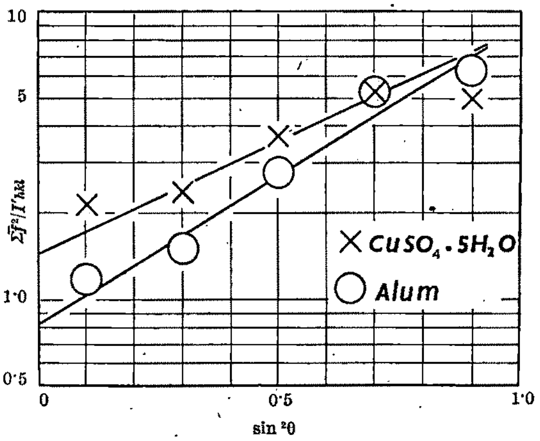
$$\begin{aligned} I_{hkl} &= \sum_{\alpha}\sum_{\beta} f_\alpha f_\beta \exp\{2\pi i[h(x_\alpha - x_\beta) + k(y_\alpha - y_\beta) + l(z_\alpha - z_\beta)]\} \\ &= \sum_{\alpha} f_\alpha^2 + \sum_{\alpha \neq \beta}\sum f_\alpha f_\beta \exp\{2\pi i[h(x_\alpha - x_\beta) + k(y_\alpha - y_\beta) + l(z_\alpha - z_\beta)]\}, \quad (1) \end{aligned}$$

where the f's are the structure factors and the x,y,z's the parameters of the atoms. Suppose that I_{hkl} is averaged for all reflexions in a given range of $\sin^2\theta$. If $\lambda/\sin\theta$ is small compared with the interatomic distances, the exponential terms in equation (1) will take on both positive and negative values, and their average over h,k,l will be practically zero. Then to a close approximation

$$\overline{I_{hkl}} = \sum_{\alpha} \bar{f}_\alpha^2, \quad (2)$$

where the $\bar{f}$'s are the atomic structure factors for the centre of the range of $\sin^2\theta/\lambda^2$.

The experimental value of the intensity of the *hkl* reflexion, I'_{hkl}, will differ from I_{hkl} by two factors a scale factor independent of θ, and the temperature factor. The ratio $\overline{I'_{hkl}}/\overline{I_{hkl}}$ for the group of reflexions will be the product of these. By dividing the reflexions into groups covering suitable ranges of $\sin^2\theta/\lambda^2$ and forming the ratio $\Sigma\bar{f}^2/\overline{I'_{hkl}}$ for each group, the factor $1/c$ required to convert I'_{hkl} to I_{hkl} will be found as a function of $\sin\theta/\lambda$. If the usual form of the temperature factor ($\exp\{-B\sin^2\theta/\lambda^2\}$) is correct, the logarithm of $1/c$ should be a linear function of $\sin^2\theta/\lambda^2$



In normal Fourier and Patterson syntheses it is usual to work only with a zone of intensities, say, the *hk*0's. If two atoms are close together in the projection, they ought to be counted as a single atom with atomic factor equal to the sum of their respective atomic factors. Since in general such coincidences cannot be predicted, there will be an error tending to make the value of $1/c$ too small. In special cases (for example, alum[3], in which the potassium and aluminium atoms coincide in the *hk*0 projection) certain coincidences can be predicted from the space group only, and allowed for.

To test the feasibility of the procedure, it has been applied to the *hk*0 reflexions of alum[3] and copper sulphate[4]. The ranges of $\sin^2\theta$ used were 0–0·2, 0·2–0·4, . . . 0·8–1 (copper radiation), but little reliance can be put on the average for the 0–0·2 group The values of f were taken from the Internationale Tabellen[5]. The logarithm of $1/c$ is plotted against $\sin^2\theta$ in the graph above. The points scatter somewhat, but lie fairly well on straight lines. Since the measurements[3,4] are 'absolute', the values of $1/c$ for $\sin^2\theta = 0$ should be 1. Actually they are about 0·8 and 1·[illegible] respectively. Without further investigation it cannot be claimed that the method is capable of high accuracy, but even that indicated should be usefu in much structure work.

A. J. C. WILSON.

Cavendish Laboratory,
Cambridge. June 18.

[1] Yü, NATURE, 149, 729 (1942).

[2] Yü, NATURE, 149, 638 (1942).

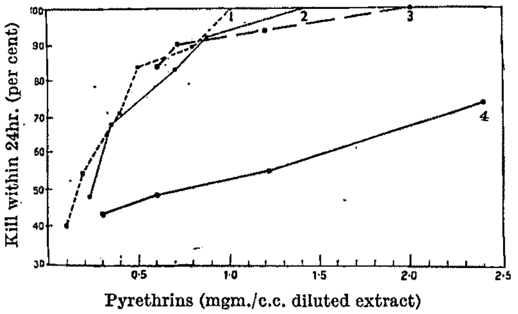
[3] Lipson and Beevers, *Proc. Roy. Soc.*, A, 148, 664 (1935).

[4] Beevers and Lipson, *Proc. Roy. Soc.*, A, 146, 570 (1934).

[5] "Internationale Tabellen zur Bestimmung von Kristallstrukturen" 2, 571 (Berlin: Gebrüder Borntraeger, 1935).

A New Active Constituent of Pyrethrum Flower

THE pyrethrin content as determined by the chemical process is the only factor that influences the market value of pyrethrum, as it is held that a close relationship exists between the amount of pyrethrin present and the number of insects killed. The results of our experiments (see graph) carried out with different samples of pyrethrum, clearly indicate that (1) the percentage kill of insects bears no direct relation to the amount of pyrethrin present in the samples, (2) a smaller amount of pyrethrin extracted from a sample yielding a high pyrethrin value produces better biological results than a larger amount from a poorer sample.



1. PYROCIDE 20. PROPRIETARY EXTRACT.
2. PREPARED FROM *Chrysanthemum cinerariæfolium* (INDIAN); PYRETHRIN CONTENT, 0·702 PER CENT.
3. ,, ,, *C. cinerariæfolium* (JAPANESE); PYRETHRIN CONTENT, 0·602 PER CENT.
4. ,, ,, *C. roseum* (INDIAN); PYRETHRIN CONTENT, 0·247 PER CENT.

It therefore follows from the above that in addition to pyrethrins I and II, the only active constituents so far known, there exists some other toxic principle which operates in the same way as pyrethrin in the production of the characteristic effect of pyrethrum on insects. As the nature of this new substance is not known, it may be designated as *X*. Why a smaller quantity of pyrethrin from a rich sample of pyrethrum produces better results than even a considerably larger quantity extracted from poorer samples may be explained by the fact that the active principle *X* exists in larger amount in the former than in the latter. This also accounts for the fact that a sample of pyrethrum possessing a high pyrethrin content yields better results than another with a lower pyrethrin value.

The results also suggest that the action of the new active principle *X* is not complementary to that of pyrethrin. It is probably an independent body, the growth of which in the flowers is regulated by the same factors as pyrethrin. Both, however, are soluble in kerosene.

The present work confirms our previous finding that kerosene extract prepared from the sun-dried residue left after the removal of pyrethrins I and II from a sample of pyrethrum flowers was found still active, and this led us to arrive at the tentative conclusion that in addition to pyrethrins there were other substances which were responsible for the destruction of insects and mosquito larvæ[1].

For each experiment a hundred flies, *Musca vicina*, all three to five days old, were employed, and our results represent the average of three observations carried out on successive days. The extracts were prepared for us according to the method used for chemical assay[2]. Kerosene was used as the vehicle for diluting the extract; this in itself has not been shown to possess any appreciable insecticidal properties.

The biological variation from the mean calculated from the results of three experiments ranged between 0 and 5 per cent in each instance.

Sample (1) is a commercial standardized preparation known as Pyrocide 20.

D. N. ROY.
S. M. GHOSH.

Department of Medical Entomology,
School of Tropical Medicine,
Calcutta. April 21.

[1] Chopra, Roy and Ghosh, *J. Mal. Inst. Ind.*, 3, 457 (1940).

[2] Lahiri, Ghosh and Chopra, *J Amer. Pharm. Assoc.*, 30, 72 (1941).

A Recording Paper for Field and General Use

AUTOGRAPHIC instruments frequently use a recording paper coated with metallic oxides, on which a black trace is made by a style of copper or silver. While this paper is very convenient, it is not always suitable for field work. To meet the need for a recording paper that would withstand difficult conditions, a special paper has been developed at the Road Research Laboratory. The following details of the process are given in the hope that they may be of use to other workers.

A good quality thin tracing paper, having a smooth surface, is damped and lapped round the recorder drum, the overlap of the paper being fixed with ordinary gum. On drying, the paper shrinks and stretches tightly round the drum, giving a very firm surface with a scarcely perceptible joint. When dry, the paper is spray-painted with a suspension of zinc oxide in dilute cellulose varnish. The resulting surface is pure white in colour, with a smooth matt texture, and on it a hard bronze style makes an excellent black trace.

Drums so coated can be used up to a very high writing speed; a time-base of 300 in. per sec. has been used with complete success, and there is no indication that higher speeds could not be used. The paper surface is strong enough to withstand the style running many times over the same base line without the paper being cut, and the hard bronze style keeps its point very satisfactorily.

In particular, the paper is waterproof, in the sense that rain falling on the paper can be wiped off without affecting the surface. Indeed, records have sometimes been irrecoverable for some days after use, during which period they have been exposed to rain with no damage to the record. It is not desirable to expose the paper to prolonged damp before use, as ultimately the paper absorbs water, swells, and becomes slack on the drum, but an accidental splash does not matter. When damp conditions are likely to be met, the cellulose coating should be rather thicker than is normally used.

After use, the paper is removed from the drum by slitting it with a sharp knife: if the paper is then dry it will come away cleanly from the drum. The resulting records are fully permanent, and will withstand any ordinary handling, filing, etc. They can be written on with pen or pencil, and pencil marks can be erased as with any ordinary paper. The sheets are also sufficiently translucent to allow records to be compared by superposition, or to be measured by putting them over a sheet of strongly marked squared paper.

There is nothing difficult in the preparation of the paper, and a stock of ready-coated drums is a convenience, especially in the rough conditions of large-scale field tests. **A. G. Tarrant.**

Road Research Laboratory,
Department of Scientific and Industrial Research,
Harmondsworth, Middlesex.
July 14.

The Polygene Concept

Dr. Paul G. 'Espinasse voices[1] misgivings about Mather's polygenic interpretation of selection which are, no doubt, widely felt outside the field of genetics. Each step in the development of genetic theory has given rise to such misgivings. Mather's explanations of his experiments, however, cannot be dismissed as epicyclic (nor for that matter will epicyclic explanations always explain anything). The assumption of polygenes is not even *a priori*. Hereditary properties are very generally known to show mutation, segregation and linkage. Polygenic variability depends on units, factors, elements, or (why not say it ?) genes, which show mutation, segregation and linkage. These are indeed the required criteria. Many important hereditary properties are not individually identifiable. There are hundreds of incompatibility or self-sterility genes known in flowering plants and fungi. Sometimes these genes include only one allelomorphic series, sometimes two. In either case they are not individually but only relationally identifiable. Yet for twenty years no one has questioned the validity of the gene explanations of Kniep and East.

Again, in Œnothera there are complex gene differences the linkage, segregation and mutation of which are responsible for the hereditary properties of a large group of species and their hybrids. The genes responsible are located in particular parts of particular chromosomes. No one has estimated their number. No one probably will do so. But that the particles responsible have the chemical constitution, mechanical arrangement and physiological properties recognized in the genes of maize and Drosophila no one doubts.

The "real methodological difficulty" for Dr. 'Espinasse depends on the polygenes being too small in their individual effects to be separated and counted. This was held to be the real methodological difficulty in the way of accepting the atomic theory. It is the kind of difficulty that arises in the making of any hypothesis. It is a difficulty, however, which is habitually relieved by new discoveries. In this case already it can be slightly relieved. Most plants and animals contain in their chromosomes, apart from the ordinary material which is recognized as carrying the genes of large effect, other parts carrying no identifiable genes. These parts were formerly regarded as inert. Yet they have recently been shown[2] to exercise an effect on cell processes which influences the character of the whole organism. Their influence is so profound as to be less specific than that of the active genes. They are therefore less readily identifiable. None the less they are the demonstrable object of selection, both natural and artificial; and the numbers of genes in them are quite beyond estimation. Indeed there cannot be much doubt that they fulfil the conditions required by Mather's polygenes. This again is a hypothesis. But it is not an epicyclic hypothesis. On the contrary, it shows that coherence with experimental breeding and with chromosome study which is characteristic of genetic theory.

John Innes Institution, **C. D. Darlington.**
Merton, S.W.19. July 1.

[1] Nature, 149, 732 (1942).

[2] Nature, 149, 66 (1942).

May I suggest that the difficulty in respect of the polygene concept, familiar to earlier writers as the theory of multiple or cumulative factors, put forward by Dr. 'Espinasse[1], is rather logical in character than, as he describes it, methodological. In simple genetics the breeding behaviour exhibited in a group of experiments is 'explained' by a few Mendelian factors, the effects of which are sufficiently different for them to be recognized individually. In the case of many quantitative characters the phenomena of heredity open to observation may be 'explained' on the supposition that there are many Mendelian factors having similar, though not necessarily identical effects. In 1918 I was able to show that such a view accorded well with every feature of the phenomena brought to light by the biometrical study of inheritance in man[2]. When Dr. 'Espinasse asks "What is the scientific value of such an explanation ?", the answer is the same in both the cases. Its value lies in its ability to predict the results of future breeding operations.

It is revealing to read: "In order to account for the behaviour in heredity of a variable quality . . . it seems now to be assumed that its behaviour depends upon the distribution of members of several such pairs, of which there may be no independent knowledge". Though the notion is new to him, Dr. 'Espinasse might at least recognize its obviousness and simplicity. The factors postulated are inherited by the same rules which factors investigated independently have been shown to exhibit. They are supposed to be linked in the same systems which have been discovered by the study of individual factors. Does Dr. 'Espinasse find a 'methodological' difficulty in geology when the existence of granite on the surface of the earth leads to the supposition that a similar substance may exist in regions inaccessible to direct observation ?

One of the features to which I directed attention in 1918 is that the hereditary behaviour to be observed does not become more complex as the number of factors is increased. Just as, in the theory of gases the gross behaviour of a molecular aggregate does not depend upon any accidental and momentary configuration of the particles, with its endless complexity, but upon a few constant statistical properties of the aggregate, so it is with the simultaneous action of numerous Mendelian factors. Dr. 'Espinasse's suggestion: "If the number of such pairs invoked as relevant be increased just until they are sufficient to explain the observations", shows a total misapprehension of this situation. In studying the selective response in lint-length of cultivated cottons Panse, for example, has recently exhibited[3] parallel models, some using few (only three) factors, and others an infinite series. The number of factors involved is in fact one of the least influential features of the systems investigated. **R. A. Fisher.**

Galton Laboratory,
Rothamsted Experimental Station,
Harpenden, Herts.

[1] 'Espinasse, P. G., Nature, 149, 732 (1942).

[2] Fisher, R. A., *Trans. Roy. Soc. Edin.*, 52, 399 (1918).

[3] Panse, V. G., *Ann. Eugen.*, 10, 76–105 (1940).

RECENT ADVANCES IN AMERICAN ARCHÆOLOGY

THE sessions of the first day of the annual general meeting of the American Philosophical Society, held in the Hall of the Society, Independence Square, Philadelphia, during April 23–25, were devoted to a ymposium on "Recent Advances in American Archæology", and were followed by a lecture in the evening by Dr. Sylvanus G. Morley on the work of he Carnegie Institution in Central America and Mexico, to whom the Society's Franklin Medal has been awarded for his investigations in this field.

"The Problem of the Eskimo" was discussed in he opening paper by Dr. Aleš Hrdlička. The Eskimo are one of the largest, still most pure-blooded, and in many respects among the most important of American native groups, and deserve, therefore, all possible scientific attention. They are, moreover, in he flux of a rapid change towards civilization, and all this carries with it, which by itself offers a great interest to the scientific observer. The anthropoogical problem of the Eskimo is not simple. It comprises the questions of their racial identity; their place of origin and antiquity; their relation to the Indian; the modes of their immigration; the reasons of their peculiar spread; the limits of this spread; he cultural history of the people; their physical characteristics; their homogeneity or heterogeneity; their relation to the Asiatic peoples; their relation o the south-western Alaskan groups; the present status of and changes in the Eskimo; their admixure with Indians, with Whites, with Negro; their diseases; and their prospects, demographic and anthropological, for the future.

"The Aztecs: their Cultural and Historical Position in Middle American Archæology" was the subject of a paper by Dr. George C. Vaillant. For various reason the Aztecs occupy an important place n Middle American archæology. They had one of he highest cultures in the Americas at the time of he Conquest. They have been more carefully observed since the sixteenth century than any other ribe in North or South America. In addition, they had their own manuscript records, which are capable of historical interpretation. Thus, from the point of view of achieving the full picture of American Indian civilization, we have more information than for any other part of the Americas.

There seems to have been in the Middle American area first an era, indefinite as yet archæologically, whereby peoples took their first steps toward agriculture. Next follows a long period of sedentary village life based on agriculture. Then came the development of the theocratic State involving pyramid construction, establishment of a pantheon, he creation of some sort of a calendar system and ome type of writing. These traits were developed by a number of tribes who were completely independent racially and linguistically, and there was a onstant type differentiation in style and form in heir handling of these generalized problems. Apparntly, about the eleventh century these ritualistic ivilizations began to collapse, partly from internal causes and partly from external pressure of a military and political nature. The effect of this change is manifested by the presence of Nahua-speaking people diffused over a wide area. As a corollary to this xpansion in Middle America we have in South America the creation of the Inca Empire, the only true empire in the Americas, and in North America evidence of tribal movements strongly affecting the population of the south-western United States and the south-east as well.

Prof. Harold S. Colton presented a "Reconstruction of Anasazi History". This group of prehistoric Indians, who lived on the plateau areas in the South-west, can be divided into six or more separate tribes, each with an independent history. Although all these tribes have much in common, they can be distinguished one from another over a long period of years.

In reconstructing their history, tree-ring studies have furnished a time-scale, calibrated in terms of our own era. Besides this we must recognize the following factors: (1) the persistence of certain culture traits, and (2) the diffusion of others. We must recognize and study the properties of frontiers between the Anasazi tribes themselves and between the Anasazi tribes and the surrounding non-Anasazi neighbours. We must recognize crises in the history of each, dominance or climax as well as the influence of trade and trade routes. From these factors it is possible to reconstruct the history of each separate cultural unit.

Dr. Dorothy Cross described "The Effect of the Abbott Farm on Eastern Chronology". These excavations on the Abbott Farm, along the Delaware River bluff, south of Trenton, New Jersey, have disproved former theories of both a pre-glacial and a clearly defined 'argillite' culture. The artefacts obtained from excavations on the forty-five to seventy-five foot bluff had a vertical distribution similar to that noted on most New Jersey sites, namely, they fall into a normal frequency curve with the peak three to four inches below the 10-in. plough line. No definite levels were discernible, and cultural changes were meagre.

The excavations on the marshy lowlands at the foot of the bluff disclosed three former humus layers, the lowermost 9 ft. from the present surface, separated by virtually sterile layers of sand and gravel. The culture in each humus layer was similar and the human remains showed the same physical type. Pottery of the same texture, surface finish, tempering and decoration was found in all humus layers in the lowlands and at all cultural-bearing depths on the bluff. Although argillite and shale were the most used materials, they were not concentrated at any given depth. Blanks, which were formerly confused with 'palæoliths', were found at all depths and of all materials, including jasper.

Traits diagnostic of certain foci and aspects in regions adjacent to New Jersey are well integrated at the Abbott Farm, and lack the chronological implications they appear to have elsewhere. The Abbott Farm has produced more than a hundred thousand artefacts and potsherds, which, by substantially eradicating negative evidence, may partially account for the uniformity of culture.

Prof. Fay-Cooper Cole's paper, "Chronology in the Middle West", dealt first with the chaotic condition of Mid-Western archæology which existed until a few years ago. Eventually several institutions collaborated in a series of field and laboratory conferences to discuss methods of excavation and fundamental problems, and out of this came the Mid-Western taxonomic system which has brought about systematic treatment of the data.

At present two widespread patterns of culture, with many subdivisions, are recognized and their chronological order determined. Hints of an early pre-pottery horizon occur, then follows an early Woodland, out of which several distinct divisions emerge. Such names as Red Ochre, Black Sand, Central Basin, Lake Michigan, Baumer and Lewis stand for well-established cultural complexes which can be traced over wide areas. Into this situation came influences from the south and south-east which, meeting with Central Basin, produce the Illinois Hopewellian with its spread into Indiana and Iowa. A similar meeting with Lake Michigan appears to produce the Hopewell of Wisconsin. The early stages of the Mississippi pattern are lacking, but the late, fully developed complex with large settlements, truncated pyramids, and a great variety of cultural objects spreads over much of the Middle West. Upper Mississippi extends its influence over northern Illinois, Wisconsin and Iowa, where it continues into historic times as the Winnebago and Ioway Sioux.

Shortly before the coming of the Whites, great cultural shifts take place and the northern Woodland groups, known to the early settlers, become established.

Prof. Willian S. Webb described "Early Horizons in the Southeast". Artefacts typologically similar to those from the Lindenmeir site have been found *in situ* at two sites in Kentucky and in Georgia. These suggest the possibility of a South-eastern Fulsom cultural horizon. While these sites are non-pottery, and all evidence points to considerable antiquity, the absence of stratigraphy leaves their chronological placement undetermined. Deep shell middens on the banks of large streams in Alabama and Kentucky show long occupancy, and a distinctive cultural complex. Sites are either entirely non-pottery or have a non-pottery component at their base. Stratigraphy demonstrates that in Alabama this complex antedates all pottery-making peoples. The material culture complex is dominated by the use of worked bone and antler, and shows the atlatl in use in a variety of forms. Polished stone atlatl weight and large flint projected point are common.

T. M. N. Lewis discussed "Late Horizons in the Southeast". Interpretation of the late archæological horizons in the South-east, he said, is obliged to take into consideration the historical facts concerning the identities, characteristics and distributions of the various Indian tribes at the time of White contact. Even more important than the internal developments of the tribal cultures is the unravelling of the acculturation processes which were operative. The earlier occupants did not always disappear from the region, but tended to be displaced and their cultures modified by contacts with later peoples. Desirable village sites were successively occupied by peoples of divergent cultures and the remains are frequently inextricably mixed notwithstanding the fact that desposits are occasionally deep and stratified.

Three of the widely recognized archæological manifestations of the eastern United States, the Woodland, Hopewellian and Mississippi complexes, are not only involved in the longer perspective of south-eastern prehistory but also represent the important factors in the late horizons. Other more restricted south-eastern elements are also included in the late manifestations of this cultural province.

The chronological sequences of the various cultural entities which have been established in the areas of the South-east, where intensive investigation has recently been carried on, can be reconciled in a general way. These sequences are not always the same throughout this large region, but the majo influences are discernible in comparable chronologica relationships and the interpretations can be coordinated.

The major impediment in applying the Midwester Taxonomic System to the South-east lies not in th principles of the system but in the fact that th determinants for the broader categories, such a pattern, phase and aspect, were set up largely on th basis of northern data or upon limited data fron the South-east.

The most positive ethnic identifications of the protohistoric and historic cultures of the South-east hav been confined mostly to the tribal groups of th Muskoghean linguistic stock, but there are some mor speculative recognitions of cultures of ethnic groups such as the Yuchi, Cherokee and Shawnee, whic give promise of eventual substantiation and acceptance.

Frank C. Hibben read a paper describing "Discoveries in Sandia Cave and Early Horizons in th Southwest". Sandia Cave lies on the east side of th Sandia Mts., some eighteen miles from the town o Albuquerque, New Mexico. Excavations in th Sandia Cave were carried on during 1936–39 an also included tests and explorations in several othe cave sites in the Sandia-Manzano area.

The chief importance of the Sandia site lies in it stratigraphy, which involves an already well-established horizon of early man, the Folsom. The stratigraphic sequence of the cave involves, from the mos recent to the earliest remains, a superimpose stratum of dust and bat accumulation containing i its topmost accumulation a 3–6 in. layer of solidifie calcium carbonate; below the calcium carbonat crust a considerable layer of varying thickness consisting of charcoal fragments, flint chips, bones angular rock fragments, and other cave debris wit intermixed Folsom points, gravers, scrapers, an other implements, indicative of a Folsom horizon below this Folsom cave occupation, a stratum o sterile yellow ochre; beneath the yellow ochre another cave floor with associated debris of bones charcoal, and implements of a shape and manufactur different from the superimposed Folsom varieties these earlier and lower placed points being distinguished by a side shoulder and rougher chipping a compared with the Folsom, and called, from the cav site, 'Sandia points'; below the Sandia level anothe sterile layer to bedrock. This stratigraphy is supported by the included mammal remains, whic indicate that the Sandia and Folsom levels are lat Pleistocene in date, as all large forms are of extinc species, and that the stratum above the calciu carbonate is recent, since only the sloth is found i the lowermost portion of this level.

In another cave in the same region, Manzano Cave additional stratified discoveries were made whic added to the above sequence. Projectile points an bola weights were found in a stratum correspondin to the Early Recent of the Sandia Cave. These projectile points are similar to those of Gypsum Cave On a basis of these discoveries, then, the followin sequence of events concerning the history of th Palæo-Indian may be proposed:

Manzano: Gypsum Cave, camel and sloth association; Early Recent
Wet period: end of Pleistocene.
Folsom: bison, horse, mammoth association: end Pleistocene o Early Recent.
Wet period: late Pleistocene.
Sandia: bison, horse, mammoth and mastodon association; lat Pleistocene.

In a paper entitled "A Possible Cochise-Mogollon-Hohokam Sequence", Emil W. Haury pointed out hat in recent years American archæologists have established several culture groups on hunting and food-gathering planes of subsistence which have been assigned to time levels ranging from about 10,000 to 20,000 or more years ago. Folsom, Sandia, Clear Creek, Gypsum Cave, Lake Mohave, and Cochise remains are a few of the manifestations. While the tendency in these studies has been to push the history of man back into antiquity, refined dating methods, and particularly the development of the tree-ring dating technique, have caused the chronologies of the 'higher', or agricultural people, as for example the Basketmaker-Pueblo, to be revised upward and shortened over previous estimates. An ever-widening gap between the early and the late groups has consequently resulted and doubts have been expressed as to the possibility of establishing any continuity between the two.

An exception to this situation may be found in the southern portion of the South-west, where the Cochise Culture existed. This culture, as reported by Sayles and Antevs, has three recognizable stages, the earliest of which is dated at more than 10,000 years ago, and the latest stage ending approximately 500 B.C., or just before the appearance of pottery and presumably agriculture.

Combining the evidence which has been gathered from open sites and from Ventana Cave, recently excavated by the Arizona State Museum, there are grounds for postulating that the agricultural and pottery-making Hohokam and the Mogollon Cultures have roots which dip into the Cochise complex. Expressed in other terms, the addition of pottery, agriculture, and possibly a few minor traits, to the lithic industry of the San Pedro Stage of the Cochise Culture, produced the earliest known ceramic horizons of the Hohokam and the Mogollon. The early phases of these two groups have much in common, especially ceramically, and it would appear that a common parentage may be claimed.

In a discussion of "Folsom and Yuma Problems", Edgar B. Howard said that satisfactory proof is still lacking to give more than a relative dating for the length of time man has been on the American Continent. Extreme estimates range from about 2000 B.C. to 70,000 years or more ago. The Folsom problem, then, is only part of the broader one dealing with answers to the questions: How long has man been in America? Where did he come from? How did he get there? Before any attempt can be made to answer these questions it is essential to have some understanding of what constitutes a Folsom point and a Yuma point, since reference to these types of spear points appears in every discussion of early man in America.

No matter from what angle the question is approached, one becomes aware of its complexity. It is made up of what appears to be a number of unrelated problems, which, in reality, are parts of the same broad puzzle, namely, man. Many secrets, so far as America is concerned, are locked up in Siberia. Until we know more of the glacial geology, anthropology, and archæology of this region, we cannot hope to answer, with any degree of satisfaction, questions such as that relating to migration routes, the culture stage reached by these early wanderers, and many others which are necessary as a foundation to a real understanding of American prehistory.

L. S. Cressman described "Cave and Lake Bed Cultures of South Central Oregon in the Northern Great Basin": Cave deposits of camp debris separated by pumice have been excavated in south central Oregon. The pumice, which came from the eruptions of Mt. Mazama and formed Crater Lake in the Cascade Mountains, has been given an age of not less than 5,000 and not more than 10,000 years by Dr. Howel Williams. The cultural material above does not differ from that below the pumice except in quality. Caves east of the pumice area contain the same kind of material.

These eastern Oregon caves show the transition from the atlatl or spear thrower to the bow and arrow. Fine twined basketry, the most conspicuous type of article found in the caves, must have been brought in by migratory peoples, for it appears completely developed immediately following a period without basketry. In the eastern caves near the end of the occupation were found a few fragments of coiled basketry. Well beneath the pumice in one of the stratified caves were found chipped obsidian tools, bones of horse, camel and several other genera along with the camp fires used to cook the flesh of these animals.

The bed of an ancient lake has given us three horizons: (1) the oldest, when horse, camel and some elephant-like animal slaked their thirst at the dwindling water holes and were hunted by man; (2) a second, about the shore-line when the lake was beginning to refill about 4,000 years ago; and (3) the historic Modoc culture about the modern shore line, dating from about the beginning of the Christian era.

Analysis of the basketry shows relationship with the culture of the earliest period of Lovelock Cave and the Humboldt Caves of the same region; technological details suggest a relationship with the Basketmaker cultures of the South-west. L-shaped awls made from the scapula of large animals suggest the Oregon - early Lovelock - Basketmaker relationship. Given the lapse of time indicated by the pumice, the Oregon material is antecedent, and perhaps ancestrally related, to certain elements of the classical Basketmaker culture.

In a paper on the "Archæology of the Andean Field", Wendell Cl. Bennett said that Peruvian archæological chronology has long been based on the sequences established by the extensive work of Max Uhle. Only recently has the importance of the Chavin style and culture been demonstrated, although it has long been recognized by such leading Peruvian archæologists as Julio C. Tello and Rafael Larco Hoyle. An examination of the site of Chavin on the River Marañón in the north highlands of Peru reveals a distinctive architectural style, a stone carving style based on the feline concept, and a simple monochrome incised ceramic style. Discoveries on the coast of Peru show similar ceramics at early sites in Ancon and Supe valleys, and more ornate ceramics with incised and relief designs similar to those on Chavin stone carving at many other sites in such valleys as Casma, Nepena, Viru, Chicama, Lambayeque and Piura. These discoveries show that the coast Chavin period is associated with buildings made of rough stone and conical adobes, sometimes with plastered walls elaborately carved and painted. Flexed burials covered with red paint were found by Larco in Chicama valley associated with the Chavin ceramics plus objects of gold, bone, shell, and stone all incised or carved with the typical designs.

A review of the above evidence indicates that:

(1) Chavin is older than any period yet discovered on the north coast of Peru; (2) as a style Chavin has a wide distribution throughout Peru and bids fair to become a third pan-Peruvian period along with the Tiahuanaco and Inca periods; (3) the ramification of styles pertaining to Chavin together with its antiquity and distribution make it one of the basic factors in the revised chronology.

CAUSES OF INTERTIDAL ZONATION

On June 18 and July 9, the Linnean Society of London, under the chairmanship of the president, Dr. E. S. Russell, discussed the causes of the intertidal zonation of plants and animals. The discussion was opened by Prof. T. A. Stephenson, who attempted to elucidate the reasons for both the vertical zonation and the horizontal distribution round the coast of the common intertidal organisms of South Africa, as observed by himself and his collaborators during the years 1931–40 (see Nature, 143, 503; 1939). In his introductory remarks Prof. Stephenson stressed the importance of field observation, as well as that of laboratory and field experiment, for the interpretation of intertidal phenomena, and pointed out also that since much of what is observed between tidemarks is evidently due to the operation of complexes of factors, it is doubtful whether much is to be gained by too great insistence on the part played by each individual factor in a complex. After a review of a number of the factors which may be expected to be concerned in intertidal processes (nature of substratum, desiccation, temperature, wave-action, feeding-habits, competition for food and space, salinity, submergence and emergence, oxygen, carbon dioxide and hydrogen ion concentration, nutritive salts, light and taxes) the conclusion was reached that there is scarcely any factor the effect of which between tidemarks can be imagined which is unable to produce *some* effect on zonation, although certain factors are undoubtedly more important than others; and that the effect of some factors is much more local than that of others. It was further concluded that the principal agent responsible for the *horizontal distribution* of organisms around South Africa is sea temperature; that for *zonation on open rock* the controllers of primary importance are degree of exposure to the desiccation-heat-light complex acting together with degree of exposure to wave action; that for *zonation in rock-pools* the leading factors appear to be variations in temperature and salinity; and that *light* is probably more generally effective in determining the segregation of shade-loving from surface species than in contributing to the actual zonation. In all cases there are subsidiary effects due to causes other than the major ones.

Dr. J. S. Colman next contributed an account of some interesting intertidal enigmas, contenting himself with describing certain distributions for which explanation is urgently needed but which, up to the present time, remain quite unexplained. This contribution brought out very clearly what was recognized by all speakers, that although papers such as those contributed to this discussion introduce "an element of reason into a distribution which could previously best be described as orderly but irrational" (Dr. Colman), yet the rationalizations hitherto attempted are undoubtedly too simple and very fa from being able to explain all the facts observed.

The third speaker, Dr. E. M. Delf, dealt with th significance of the exposure factor in relation to zonation, enumerating its components: this contributio was in line with those of earlier speakers, and adde reinforcement by means of a different selection o details, bringing out once again the fact that intertidal phenomena depend on complexes of interactin factors.

The meeting was then thrown open for discussion and Dr. G. P. Bidder contributed a number of interesting examples taken from among the sponges, som of which threw additional light on points raised by previous speakers, while others introduced furthe features of intertidal life which had not previousl been dealt with. Prof. L. Newton followed with som comments referring to algæ, noting particularly that at least in Britain, the nature of the substratum may become important locally as a factor determining th nature of the flora; and that in past discussions o algal zonation the effects of light had probably been overestimated. Prof. Stephenson, Dr. Colman and Dr. Delf replied briefly to these comments.

On the resumption of the discussion on July 9, Mr. A. D. Cotton, in the unavoidable absence of the author, read a paper by Dr. V. J. Chapman on the horizontal distribution and vertical zonation of marine algæ on rocky shores. Dr. Chapman limited his attention to the common Fucoids. He found himself in agreement with Prof. Stephenson's opening remarks as to the validity of field-work as well as of experiments in the search for the causes of zonation, and also agreed that, of the factors controlling horizontal distribution, temperature appears to be the leading one. Passing to the question of critical levels between tidemarks, Dr. Chapman compared the work of several authors and synthesized their observations for five different localities, concluding that the existence of certain critical levels may be a reality despite undoubted local variations. In an assessment of the various factors the operation of which will render one level more critical than another, the effects were reviewed of mechanical exposure, substratum, submergence and emergence, exposure to air, temperature, illumination, salinity, gaseous exchange and nutrient salts, desiccation and biota. These factors were classified as *causal*, *presence or absence* and *modifying* factors respectively. Lastly Dr. Chapman considered the relation of algal zones to tidal levels in the light of the foregoing review, and pointed out lines along which further progress might be made in the search for the causes of zonation. Mr. Cotton, in reading the paper, added comments of his own referring to matters of detail, but no further discussion took place.

Regarded purely as a verbal discussion, this symposium was disappointing, because, as the result of an unfortunate combination of circumstances, several of those interested were unable to attend the second session of the discussion, and some of them not even the first. At the same time there was a considerable measure of agreement between the views expressed, and the subject was seen to have been somewhat clarified during recent years in spite of universal recognition of its complex nature and of the need for extensive future investigation; and the papers contributed should, when printed in the Society's *Proceedings*, form a valuable reservoir of ideas for the further development of the subject.

T. A. Stephenson.

JUNCTION LINE FILTERS

TWO articles on these filters by F. A. Hinshaw and J. O. Israel respectively (*Bell Lab. Rec.*, 20, No. 9, May 1942) describe their design and applications in communication circuits. Open-wire lines brought into repeater stations or toll offices located in densely populated areas are usually terminated at the outskirts of the area, and the circuits are brought to the office through cables. These cables are usually loaded so as to improve the impedance match between the open-wire line and the cable and to reduce the loss in the cable. At repeater stations and terminals the separation of the carrier and voice circuits is ordinarily accomplished by filters at the office end of the cable. It is not feasible to use the office filters to separate the carrier and voice circuits at the terminal pole to avoid the necessity of carrier loading. Moreover, difficulties would be encountered in obtaining a suitable balance at the voice repeater because of the imperfect impedance match of filter and cable, and of the length of cable between filter and repeater, which would be different for each installation.

These difficulties have been overcome by the development of the junction line filter and its associated networks, the principal duty of which is to separate carrier and voice currents. This separation is accomplished by two single-section filters, a low-pass and a high-pass. As soon as these filters are introduced into the line, however, several other factors become important, the most outstanding of which are longitudinal balance, reflection coefficient, and modulation. Two junction filters are available. In one, the low-frequency channel is wide enough for a 5 kc. programme circuit, while the high-frequency channel is suitable for open-wire carrier telephone systems operating at frequencies as low as 6·5 kc. In the other, the low-frequency channel is wide enough for voice frequencies up to 3 kc., while the high-frequency channel passes frequencies as low as 4·8 kc.

By the use of these junction filters, carrier loading of the longer entrance cable is unnecessary; the voice frequencies are brought in over a voice-loaded pair, and the carrier frequencies over a non-loaded pair. Certain additional equipment is also required. An impedance-matching network on the cable side of the high-pass filter corrects the impedance mismatch that would otherwise exist at carrier frequencies between the filter and non-loaded cable pair. At the office end of the carrier pair a transformer network transforms the relatively low impedance of the non-loaded cable pair to the office impedance. Since with this arrangement the office filters are no longer connected in parallel, compensating networks are required to simulate the impedance effect of one filter on the other.

The insertion of the filter at the terminal pole, however, introduces an impedance irregularity in the voice frequency pair and upsets the balance at the hybrid coil. To maintain a suitable balance, therefore, the effect of the filter and the length of cable must be duplicated in the balancing network. Where loaded entrance cable is connected directly to the open-wire line, the balancing network includes a section to simulate the low-pass filter, a section to simulate the composite set, and a two-terminal network to simulate the impedance of the open-wire line or loaded entrance cable. Where the junction line filter is employed, however, the network must include other elements to simulate both the filter and the particular length of entrance cable involved.

For simulating the transmission characteristics of the entrance cable, which may be of different length for each installation, a series of cable-simulating units has been provided. Three types of simulating networks have been developed and with a suitable combination of them and a suitable amount of building-out, any length of entrance cable can be simulated. Terminal sections are built up in a similar manner to simulate the characteristics of the terminal section.

The ability of the junction filter to operate out-of-doors under all kinds of weather conditions and its comparatively low cost make it an economical substitute for carrier loading on the longer entrance cables. While the junction filter gives transmission results sufficiently satisfactory to justify its use, it does not provide as good overall impedance matching as carrier loading, and it increases rather than decreases entrance cable losses.

'TACK' AND STICKY MATERIALS

AN informal discussion on the subject of 'tack' and sticky materials, arranged jointly by the British Rheologists' Club and the Printing and Allied Trades Research Association, was held at St. Bride Institute, Fleet Street, London, on June 10. Dr. G. L. Riddell presided.

In his introductory remarks, Dr. V. G. W. Harrison said that the purpose of the meeting was to bring together those interested in 'sticky' materials. It is still uncertain what physical properties produce 'stickiness' and it was hoped that as a result of the meeting ideas would be clarified and perhaps some preliminary investigations could be started. Those present represented a wide range of interests, and it was generally felt that an informal meeting of this kind was long overdue.

Mr. C. C. Mill opened the discussion. 'Tack', he said, is a common term in the printing and allied trades. It means, in a general way, 'stickiness', but it has no precise definition and is usually estimated by a 'finger test'. A certain amount of 'tack' is considered essential in printing ink, and it is thus desirable to have some means of defining and measuring this property. Various attempts have already been made. Recently Green (*Ind. and Eng. Chem.* Anal. Edit., 13, 632; 1941) has described a method which attempts to reproduce the finger test. He arrives at an equation in which the time taken to move a mechanical 'finger' a fixed distance is a function of the geometry of the 'finger' system and the viscosity of the material tested.

If Green was really measuring 'tack', Mr. Mill continued, then this property is identical with viscosity, and all liquids of the same viscosity should have the same 'tack', which is contrary to the usual belief. It seems probable that Green over-simplified the problem. In addition to the stress required to maintain viscous flow between the separating surfaces, a further force is required to break the film. This force is dependent on the cohesive and adhesive properties of the liquid, and thus varies from one liquid to another. Another possible factor causing 'tack' is suggested by Maxwell's conception of 'relaxation time'. With an ideal liquid the stress produced by a given strain is rapidly dissipated, but in many real liquids the time taken is much longer; consequently these liquids show elastic properties under certain conditions, and it may be found that 'tacky' materials belong to this class.

If it could be established, Mr. Mill concluded, that 'tack' is due to some combination of fundamental physical properties, it would become possible to devise standard methods of measuring it; but until something more definite is known, it does not seem worth while to continue experimenting along empirical lines. Probably the best way of solving the problem would be to get it taken up as a fundamental research by one of the universities or a research association. Some progress might be made in the meantime by preparing a set of samples with (so far as possible) known physical properties, and submitting these to 'practical men' in the industries concerned for grading according to their own crude tests for 'tack'.

In a written contribution, Mr. J. Pryce Jones said there is slight evidence that 'tacky' liquids possess surface viscosity. He adduced evidence to show that there is no direct relationship between 'tack' and viscosity as measured by a falling ball method. Dr. E. Mardles wrote to say that he has found a fairly close correlation between 'pull resistance' on a flat 'finger' and yield value as measured on a type of Stormer viscometer.

In the general discussion, Dr. G. W. Scott Blair said that 'tack', like 'firmness', may prove to be a *Gestalt*, that is, may display properties other than can be derived from the parts in summation. The terms in such a combination do not always have whole number dimensional exponents; the form of the expression depends on the *Gestalt*, which is itself influenced by the training of the person estimating the property. Usually only one of the terms in the combination (for example, viscosity) is measured instrumentally, and the system is thereby oversimplified, perhaps to such an extent that misleading figures result. A general discussion on the parts which might compose this *Gestalt* followed, in which it was generally agreed that adhesion of the liquid to the testing surface is essential. Fairly high cohesion and viscosity are also important. The 'tack' of some materials (for example, sodium alginate solutions) seems to change with speed; with a rapid motion of the finger, there is little sticking, whereas with a slow rate of break there is distinct 'tack'. The whole problem is complicated by the fact that in the finger test the dimensions of the test sample are continually changing.

Dr. L. R. G. Treloar said that most *spinnbar* materials appear to consist of long-chain molecules in solution or associations of particles, and drawing out these materials produces orientation of the particles, which makes the threads stronger. Small threads are stronger than large because of surface orientation effects. A general discussion followed on whether *spinnbar* materials are necessarily 'tacky', and vice versa. The consistency of potters' clay is judged by 'tack', yet it is not *spinnbar* and does not contain long-chain molecules. Is this 'tack' the same as the 'tack' of adhesives and varnishes? Dr. R. F. Bowles asked whether one can have a 'tacky' solid; if not, is there any limiting viscosity which must be exceeded before a liquid becomes 'tacky'. Mr. J. H. Dawe pointed out that on account of the rapid drying of adhesives, a time factor is important. He also finds it necessary to distinguish between the 'tack' which is just sufficient to keep a label in position on a bottle, and the 'tack' necessary to kee together two surfaces which would otherwise sprin apart.

Finally, it was agreed that, as a start, the Printin and Allied Trades Research Association, in collabora tion with the British Rheologists' Club, should pr pare a set of samples and submit these to experts i the printing ink, paint, adhesive, clay and pottery and plastics trades for grading. Nothing may com of the experiment, but it will serve to show whethe there are any signs that general agreement can b reached, or whether the conception of 'tack' varie from one industry to another. The samples migh also suggest what properties are mainly instrumente in producing 'tack'. The results of the experimen could be considered at a later meeting.

FORTHCOMING EVENTS

Saturday and Sunday, August 1-2

ASSOCIATION OF SCIENTIFIC WORKERS (IN COLLABORATION WITH TH FEDERATION OF AYRSHIRE SCIENTIFIC FILM SOCIETIES) (at Ayr).—Conference on "The Scientific Film and Scientific Film Societies".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on o before the dates mentioned:

GRADUATE LECTURER IN THE ENGINEERING DEPARTMENT—Th Registrar, North Gloucestershire Technical College, Lansdown Roa Branch, Cheltenham (August 10).

LECTURER IN MINING in the Chesterfield Technical College—Th Clerk to the Governors, Technical College, Infirmary Road, Chester field (August 15).

LECTURESHIP IN CHEMISTRY—The Principal, Heriot-Watt College Edinburgh (August 17).

REGIUS PROFESSOR OF ENGINEERING AT EDINBURGH UNIVERSITY—The Private Secretary, Scottish Office, Fieldon House, 10 Grea College Street, London, S.W.1 (September 7).

HARRIS CHAIR OF PHYSICS, University College, Dundee—Th Secretary, The University, St. Andrews (December 31).

LECTURER-IN-CHARGE OF MECHANICAL ENGINEERING—Th Principal, Handsworth Technical College, Golds Hill Road, Hands worth, Birmingham 21.

VISITING LECTURER IN PSYCHOLOGY—The Secretary, King' College of Household and Social Science (University of London) c/o University College, Leicester.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Food Conditions in Europe: a Statement on the Effect of Wa and Blockade on People in German-controlled Countries. Pp. 12 (London: Famine Relief Committee.) 3*d*. [14

Medical Research Council. Special Report Series No. 245: Repor of the Committee on Bed-Bug Infestation, 1935–1940. Pp. 64. (London: H.M. Stationery Office.) 1*s*. net. [157

Concrete Simply Explained. By Victor S. Wigmore. Pp. 48 (London: Society of Engineers.) 1*s*. 6*d*. net. [167

Relief and Reconstruction in Europe: the First Steps. An Interim Report by a Chatham House Study Group. (Post-War Problems.) Pp. 40. (London: Royal Institute of International Affairs.) 1*s*. 6*d* net. [17

Medical Relief in Europe: Questions for Immediate Study. B Dr. Melville D. Mackenzie. (Post-War Problems.) Pp. 68. (London: Royal Institute of International Affairs.) 2*s*. net. [177

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1941. Pp. 152. (Bristol: Th University.) [207

Other Countries

U.S. Office of Education: Federal Security Agency. Education and National Defense Series, Pamphlet No. 11: Populations Adrift Pp. v+30. (Washington, D.C.: Government Printing Office.) 1 cents. [137

U.S. Office of Education: Federal Security Agency. Educatio and National Defense Series, Pamphlet No. 1: Our Country's Cal to Service. Pp. vi+24. (Washington, D.C.: Government Printin Office.) 15 cents. [15

National Planning Association. Planning Pamphlets, No. 11: Fo a Better Post-War Agriculture. Pp. 48. (Washington, D.C.: Nationa Planning Association.) 25 cents. [20

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COLONIAL DEVELOPMENT : THE PROGRESS TO PARTNERSHIP

THE selection of speeches by General Smuts which has recently appeared under the title "Plans for a Better World"* makes its appearance at an opportune moment when, as recent debates in the House of Lords and House of Commons on Colonial policy demonstrate, many of the problems which General Smuts discusses, including the idea of trusteeship which he did so much to promote in the mandate system, are coming under close and critical review. The volume includes his presidential address to the British Association at its centenary meeting in London ; an address on science from the South African point of view ; and another address delivered in 1927 outlining his theory of holism. In this glimpse of General Smuts's views on science the volume does something to redress a conspicuous gap in Mrs. Millin's "Life" of General Smuts, and the picture it gives of the wide interests and sympathies of the author, his versatile and imaginative mind is both fair and balanced.

Interesting as is this glimpse of the secret of General Smuts's real strength—and his speeches on the Statute of Westminster, the Commonwealth Conception, his St. Andrews' rectorial address on the challenge to freedom, the Rhodes Memorial Lecture on native policy in Africa read as vividly to-day as when they were delivered ten or even twenty-five years ago, or as those of last year on "Investing in Friendship" and "A Vision of the New World Order" with which the volume closes—it is of even greater interest as illustrating the evolution of outlook and policy which is taking place in South Africa and elsewhere. That evolution is exemplified strikingly in the thought of Smuts himself. Between the views on segregation expressed in his Rhodes Memorial Lecture at Oxford in 1929 and those of his speech at Cape Town in January of this year, in which he admitted the failure of segregation, and of his still more recent "The Basis of Trusteeship", there is no small advance.

The debates in the House of Lords on May 6 and in the House of Commons on June 24 well show the extent to which the War has already shaken conventions and opened men's minds. No one reading the full debates can doubt the reality of Parliamentary interest in Colonial affairs, however much yet remains to be done to quicken interest generally and to arouse public opinion to a sense of its full responsibility in these matters. Mr. Eden's plea for the future development of the Colonial Empire in his speech at Edinburgh on May 8 had already indicated the extent to which the problems of the Colonies are before the Government as it faces the tasks of the future, and the speech of Mr. Harold Macmillan, Under-Secretary of State for the Colonies, on June 24, made it perfectly clear that the policy of the Government towards the Colonies is in no way inconsistent with the high ideals of liberty and justice which have inspired the Atlantic Charter.

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* Plans for a Better World. Speeches of Field-Marshal the Rt. Hon. J. C. Smuts. Pp. 288+8 plates. (London : Hodder and Stoughton, Ltd., 1942.) 8*s.* 6*d.* net.

The two debates in question followed somewhat different courses. That in the House of Lords put organization and administration in the forefront. In speaking on his motion on the staffing and administration of the Colonial Empire, Lord Trenchard endorsed views earlier expressed by Lord Moyne on the importance of efficient staff to enable the Colonial Office to deal effectively with social problems such as health, education and standard of living, and replan Colonial economics in production and marketing. Lord Trenchard made two proposals. First, he suggested the grouping of the Colonies into not more than a dozen areas, each having a governor-general and a central authority of its own responsible to the Colonial Office. These larger areas are necessary for purposes of defence, economic planning, medical research and the social services. The scheme outlined has points in common with one outlined in a recent *Planning* broadsheet; and in one of the suggested areas—the West Indies—there is already co-operation between Great Britain, the United States and the Netherlands, and in another—West Africa—between the British, French and Belgians.

This suggestion is in harmony with the general tendency towards larger units, and there are many fields in which the precedents of co-operation across national frontiers created during the present War may serve us well in the peace to follow. Lord Trenchard's suggestion is not indeed inconsistent with the continued existence of the smaller unit, which will still have its functions, especially among undeveloped peoples, but it might well provide the means of more effective international collaboration than has hitherto been possible under even the mandate system. In supporting this proposal later in the debate, Lord Hailey clearly indicated that in his view it offers possibilities of building up new and more responsible forms of self-government on the basis of existing local customs and institutions, especially where the units are too small in resources or with little political balance to attain responsible government or the position of a dominion themselves.

Another proposal made by Lord Trenchard was for the establishment of the Colonial Service, at home and abroad, as a single, interchangeable service, independent of the rest of the Civil Service, and that appointments to the Service should be based to a much greater extent on selection. While placing recruitment on the broadest possible basis, he urged that all types of recruit should be given first a year's training in a university which might in time come to be regarded as specially concentrated on Colonial interests. Lord Trenchard also advocated outside recruitment at the top of the Service, and warmly welcomed Sir George Gater's appointment to the Colonial Office. He also endorsed Lord Moyne's proposals for proportional pensions to facilitate retirement of Colonial officials.

Two other recommendations were advanced by Lord Trenchard as even more vital: first, the establishment of a Colonial Advisory Board, and, secondly, a Colonial Staff College to which the abler and more promising men in the Service would be drafted for a course at the age of about thirty-five. The aim would be to bring them in constant contact with each other and with the outside world, to broaden their outlook, and to stimulate their enthusiasm so as to encourage a progressive and constructive spirit Furthermore, Lord Trenchard looked to a representative Colonial Council to stimulate and focus public interest in the Colonies and bring informed opinion to bear upon them.

Generally speaking, Lord Trenchard's proposals were well supported in the debate which followed Lord Moyne considers that recruiting should be very much on the lines suggested, and he and Earl De La Warr, and also Lord Hailey, stressed the importance of bringing the largest possible number of native-born Africans and other Colonials into our Governmen services. Lord De La Warr pointed out that in great portions of Africa education and health must be treated as one subject, but in place of a Colonia Staff College he suggested a system of travelling scholarships. He stressed, too, the importance of more enterprise and courage in administration, more attention to the right political development, to the things that are the foundation of life, the intelligence, health, food and economy of the native African population. The Colonial staff should be chosen organized and trained with that essential purpose in mind.

In Lord Hailey's tribute to the present capacity of our Colonial Services, he, too, emphasized the need for men capable of dealing with economic problems, an aspect which has hitherto received insufficient attention in the Colonial Service, but he agreed with Lord De La Warr as to the high quality of some of the younger and more recent recruits. Lord Hailey doubted whether a fully interchangeable service is desirable, although he believes that interchangeability would do something to enhance the position of the Colonial administrative service and that the Colonia Office would gain substantially through the presence of a much larger number of men with actual experience of executive work and its requirements. In his view, the ideal would be to have a staff in the Colonial Office composed partly of men from the Colonial administrative service and partly of men who have had experience in other departments of Home Government, officered by the home Civil Service and departments, which deal with so many activities, social and economic, now forming an increasing part of the work of the Colonial Office Lord Hailey insisted once more on the importance of the conception of the State as the chief agency for social welfare, which, forcing its way into Colonia politics, is giving us a new and more constructive and beneficial interpretation of trusteeship without diminishing its moral quality.

Viscount Elibank, in supporting the idea of a Colonial Staff College, advocated, not so much the refresher courses, as selection at an earlier age on the lines of the selection of Rhodes Scholars, while Lord Faringdon, referring to the friction between technica and administrative services which is liable to arise under the selection system of recruitment if the administrative service holds a superior position believes that a college to which all aspiring Civil servants should be sent would meet the difficulty, and he supports the idea of refresher courses.

Lord Trenchard's speech was welcomed by Lord Cranborne, who in replying for the Government stressed the dynamic character of the British Empire. While interchangeability could not be so somplete in the Colonial Service as it is in the Diplomatic Service, the desirability of the fullest possible mobility is fully recognized in the Colonial Office, especially in the technical branches of the Service where mobility is easier. Lord Cranborne stated that he intends to see that there is the greatest possible measure of interchange between the Colonial Service and the Colonial Office, and that this is one of the reasons for the appointment of Sir William Battershill as Deputy Under-Secretary and of Sir Cosmo Parkinson as his personal representative to maintain contact with the governors in the Colonies.

In regard to recruitment, the procedure proposed by Lord Trenchard is already largely the normal. Lord Cranborne hopes that selection on merit will remain the Colonial Service system of entry, and he does not believe that any alteration is necessary in the system of selection. The Colonial Office is already studying methods of improving the training of both the technical and the administrative services, and the idea of a further course of one or two years training for those who have had several years experience in the Service is under consideration. Lord Cranborne also warmly welcomed the idea of giving the Government powers of compulsory retirement of officers before their time is up, so that dead wood could be cut out. He promised full consideration of the suggestion of a Colonial Staff College; but he is dubious about the proposal for a Colonial Advisory Council and believes that advice should be given in Parliament and not by an officially appointed body. As to recruitment by bringing in new blood at the top, while that is often done, much harm could come to the Service if too frequent use be made of such powers by the Secretary of State.

The whole debate in the House of Lords remained at a high level, and in his closing remarks Lord Cranborne emphasized the importance of the right spirit pervading and inspiring policy and machinery. Without a moral and ethical basis, no Colonial Service could achieve what it set out to do and our Empire would not deserve to survive. That note was noticeably lacking in the House of Commons during the debate on Colonial affairs on June 24, which was indeed of a different character.

Mr. Harold Macmillan's speech was mainly concerned with the short-term aspects of Colonial affairs, in the course of which, however, he paid special tribute to the work of the Economic Department of the Colonial Office, which has been extended. In looking to the future, he developed the same outlook as Lord Cranborne, stressing the necessity for understanding and friendship as a basis for partnership. Changes or preparations for changes in the Colonial Service should have two chief aims: first to provide increasing opportunities for the people of the Colonies to fill posts in the public service of their own countries; and second, to provide a mobile force of highly qualified experts in administration, in science, in agriculture, in mining, etc., at the command of the Secretary of State to be posted wherever in the Colonial Empire they were most needed at a particular time. The unification of the Colonial Service which has been proceeding since 1930 is to be taken a stage further for this purpose in accordance with proposals initiated by Lord Moyne which are being worked out in consultation with the Colonial governors.

Mr. Macmillan then urged that our development policy should be considered as a whole and not in single compartments, and he went on to describe the various technical advisory committees which have already been appointed, of which the most recent is the Colonial Labour Advisory Committee. Special reference was made to Lord Hailey's services in the organization of research, which must cover economic ends as well as nutrition and education, etc. To promote the increased prosperity of the peoples in the Colonies scientific research must be applied to market needs. In the long run, the standard of living and the expenditure on social services in the Colonies depend on their economic prosperity, and the Colonial Development and Welfare Act is regarded as the instrument for long-term planning. Large-scale public investment on public needs will be required, and we should now prepare the plans and priorities for capital development so as to be ready to advance our demand for a fair share of reconstruction work for the Colonies.

It is clearly recognized by the Government that systems of government or administration alone are not enough; they must be supported by vigour, decision, imagination, ruthless and overriding zeal. That view was reflected in the subsequent debate, in which a proposal for a Colonial Development Board was strongly advocated by Capt. P. D. Macdonald and Squadron-Leader P. W. Donner. Pleading for a new conception of Empire, Capt. Macdonald suggested that the proposed Board should be a statutory body under the Secretary of State for the Colonies, and in addition to a representative of the Chiefs of Staff Committee, it should include full-time members for economy and finance, health, education and housing, and all the supply departments, with power to co-opt from outside on special sub-committees. It would take over the Colonial Development Fund, and Capt. Macdonald stressed the opportunity for real statesmanship and for adequate financial resources. The five millions of the Colonial Welfare and Development Board should, he suggested, be used to pay the interest on the far greater loan of two or three hundred million pounds which is really required to tackle on an adequate scale the problems confronting us.

Squadron-Leader Donner suggested that the Colonial Development Board should have the four principal functions of the Imperial Development Board suggested by the Royal Commission of 1917. It should promote first new sources of supply, and secondly new measures for the prevention of waste; thirdly, it should investigate the possibility of finding substitutes, and fourthly, would stimulate scientific research. Recalling the weakness of the Colonies in regard to research—a position on which the Royal Commission had commented—Squadron-Leader Donner said that our Colonial administration has been weakest in dealing with economics and development.

Mr. Macmillan promised to examine the suggestions carefully, and while dubious as to the desirability of establishing the particular organization suggested, recognized the importance of study and research as a basis for policy. Instruments for making and executing plans must be included, and some continuity of policy preserved in capital development in future. In regard to the suggestion for an assurance in realistic and convincing terms, pointing the way to freedom, equality, responsibility, and the reconstruction of Colonial economic and social life, Mr. Macmillan referred to the Joint Declaration and the Prime Minister's explanatory comment.

Though it could not be said that the debate touched the high level of that in the House of Lords, it is clear that many members of the House of Commons are alive to the grave issues and responsibilities involved. Mr. R. W. Sorensen made several valuable suggestions. We should see that the whole of the Colonial Development Fund is expended on development, if not in the particular year allocated, then in the following year. Friendship between the black peoples and ourselves should be fortified by a comprehensive scheme of educational development. Our medical services also require drastic development, and if enforced labour is required, we should see that the finest conditions that can be secured are granted to the people. Finally, we should consider drawing up a plan of constitutional and political development in West Africa as well as in the West Indies.

The emphasis which is rightly being placed on economic development as the basis for Colonial stability and prosperity, and on international co-operation in the attack on such problems as soil erosion and tropical diseases, if adequate technical staff is to be available, should not lead us to overlook the importance of some of the other basic conditions and principles inherent in the idea of trusteeship or partnership between the peoples of the world on which the Atlantic Charter is based. It is not solely a matter of more imagination and creative insight in fostering the growth of self-government through new institutions more adapted to Colonial conditions than the outward forms of British institutions. Equally with economic development must come educational development, not merely of the few who must be drawn into the active conduct of affairs, but also of the many, so as to eliminate the psychological errors, misunderstanding and apathy that have thwarted in the past well-meant but erroneously conceived administrative measures. In this we must, as Mr. I. L. Orr-Ewing pointed out in the House of Commons, redress our failure to popularize education among African women, and also the tendency to excessive concentration on book-learning in education. We must educate the African to be a good African and not a mediocre European, and to develop on his own traditional lines.

That the pre-war official or accepted conception of Colonial policy is now inadequate as a guide can scarcely be questioned. The two principles of fulfilment of the obligations of trusteeship and of assisting the dependent units of the Empire to attain self-government are not really definite enough. The first is negative rather than positive, corrective rather than constructive, and, as Lord Hailey has pointed out, its moral standards are liable to too many interpretations to be a satisfactory guide. The inadequacy of the second was fully exposed in the House of Lords debate, and if we are to bring new life and strength into the system the first step may well be, as Lord Hailey suggests, the restatement of our relations not as between trustees and wards, but as senior and junior partners, on terms which recognize that the latter must as of right acquire an increasing share in the control of our common undertaking. Moreover, as we apply to the Colonial empire the conception of the State, not merely as an agency for maintaining justice or preventing abuse, but also as the most active agency for promoting social welfare and improving the general standard of living, our obligations to the Colonial peoples become not those of trustees but those incumbent on the modern State in regard to the improvement of the social services and the standards of living in its own backward areas.

That shift of emphasis in itself should prove a powerful solvent of misunderstandings and friction. By the stimulus it gives to the self-respect of the Colonial peoples it should promote the more rapid development of representative local institutions, and the full participation of the people of the country in their own administrative services. Moreover, building firmly on the basis of existing institutions so as to assist the evolution of forms of self-government best suited to the traditions and circumstances of the people should also assist in that co-operative attack on the great problems of health, nutrition and the conservation as well as development of natural resources, which will be essential on an international scale as well as within the bounds of our own or any other Colonial Empire.

CYNIC SCIENCE

The Scientific Life

By Dr. John R. Baker. Pp. 154. (London: George Allen and Unwin, Ltd., 1942.) 7*s*. 6*d*. net.

DIOGENES had only one request to make of Alexander: "Keep out of my sunlight". Insolation, to the Cynic, was what the bath, the omnibus, and the tea-tray have been to eminent physicists and chemists; and in a world overshadowed by a planned technology, Dr. Baker takes up the cause of individual freedom for men of science.

That technology is something quite distinct from science, as we understand it, Dr. Baker has little difficulty in showing. That a planned technology, which is essential and inevitable in a time of national crisis, necessarily threatens the freedom of scientific discovery, is less easy to prove. He notes unfavourable portents. The capital letters in the Wordsworthian motto of NATURE were deranged "about 1935"(p. 130), but this the Editors may restore, or replace by lower-case, which is always in anti-capitalist majority. [The change was made on the representation of scholars in order to make the quotation conform with the accepted Wordsworth text.—EDITORS.] The British Association has held a conference, and published a "Declaration of Scientific Principles" which amplified (without transgressing) its century-old commission "to give a stronger impulse *and a more systematic direction* to scientific enquiry, and to obtain a more general attention to the objects of Science, and a *removal of any disadvantages of a public kind* which impede its progress". M. Maisky has stated that "we in the Soviet Union never believed in so-called 'pure' science. We always believed that science must help humanity in its needs", in the course of an appeal which we may hope is unnecessary here, to put "first things first" in a dangerous emergency.

Dr. Baker gives entertaining and picturesque examples of the personal habits of men of scientific genius, which might be capped by those of great artists, poets, and other unusual people. Some great soldiers—and other 'planners'—have also exhibited their need of freedom. But this is the 'common-sense' or 'magical' argument which he ridicules (pp. 115–16): to make his proof secure, as one man of science to another, he must be asked to give negative and crucial instances. He does not seem to extend his protest against the use of men of science in technological research to the employment of them in another useful art, education. Indeed he carries compromise so far as to admit that teachers of science may be required to lecture punctually and on prescribed subjects, and members of a research institute to co-operate in its programme of research. It is not so long ago that the Association of Scientific Workers was upholding the right of teachers and research workers alike to reasonable conditions of pay, leisure and freedom of speech; and it is odd that some of the academic fracas of recent years have arisen over the demand of men of science for freedom, not of scientific thought or expression, but in the exercise of those civic functions which Dr. Baker regards as incompatible with the "scientific life". Here is Dr. Baker himself compromising his own 'scientific life' by this counterblast to 'planned economy' by or for a 'progressive class': a case of real self-discipline. One wonders whether the geese who saved Rome ceased to lay.

Dr. Baker rather damages his own generalization by admitting (p. 36) that at certain times "if one person had not made the discoveries, another, nearly as good, would probably have done so", distinguishing science from music in this respect. But if "the genius in science is not a man apart" (p. 37), what becomes of the case for treating him as if he were ?

For his general thesis that the desire for knowledge begins in wonder and curiosity, rather than in the desire for control, which leads to technological invention, there is much to be said. It is an aspect of the general distinction between science and technology, between discovery and invention; and it is not surprising that those who fail to distinguish these should overlook it. Dr. Baker's analogy, already noted, between science and music, between the disinterested quest of truth and the quest of beauty, is well grounded. He might have added the quest of goodness, which like the quest of truth has its technological counterpart in the social sciences, which study how to *be* good, or to *multiply* goodness among men; for this also does not originate in the desire to control evil, or lead to the effort to do so, but rather, as its votaries say, 'to see God' without consequence or corollary. Theories of origin, however, do not prejudge the claim of the disinterested 'seeker after truth', or after beauty or goodness, to freedom of thought and expression. They are only relevant in so far as they help to explain the inability of able technologists, as of some able composers, to recognize the division between disinterested and interested inquiry. Dr. Baker quotes the statement (p. 104) that "nearly all scientific discoveries have proved of practical value", which is a tautology if 'scientific' means 'technological', but untrue if it means anything more. Such statements rather confirm his doubt whether we live in a "particularly scientific age" and his view that "even in subjects which are based on science, the scientific attitude is not absolutely necessary", meaning thereby the disinterested quest of truth. Just so, there are zealous and efficient social reformers who doubt or deny the possibility of "knowing the good" in the sense in which a man of science "knows the truth" in his discoveries.

If Dr. Baker's theory of scientific discovery as a conjunction of genius and occasion is true, every community probably gets its ration of men of exceptional insight. What matters is its method of recognizing them, and the use it makes of them when found. Here all parties seem to be agreed that they are likely to be better treated, and more productive of truth, if public opinion is sufficiently cultured to appreciate what they are doing and to provide for their needs, which are usually modest. It is not the discoverer but the inventor, who needs a palatial laboratory and a highly trained team. The inventor, moreover, usually knows better how to humour the unscientific theories or wishes of the patron or party, progressive or otherwise, who will pay the bill. In the arts it is the same; it is the great decorator who lives in kings' palaces and enhances their style of living; and he is not always a great artist.

It would be unfair to Dr. Baker not to note points in which his own presentation of the "scientific life" might be clarified. His classification of the sciences as basic, intermediate, expanded and eclectic is novel and needs explanation; for he seems to exclude mathematics, and to include psychology in biology—though he admits a "temporary gap" between psychological and physiological studies; he underestimates 'experimental' biology, which is as essential as 'experimental' physics; he includes geographical distribution under biology, though volcanoes are geographically distributed, and animals and plants depend for their diffusion on soils and climate; and he overlooks the 'observational' side of pharmacology, where Sir Henry Wellcome spent large sums fruitfully on the folk-lore and folk-medicine of remoter peoples. His use of well-established terms like 'substance' and 'form' is perplexing; he speaks (p. 95) of the "analytically minded person" as interested "in substance rather than form, in the general rather than the particular"; but perhaps he is one of those persons "untrained even in the elements of logic" who are "usually logical enough for all the purposes of ordinary scientific research" (p. 89).

Dr. Baker has several suggestions for the advancement of science: more Nature reserves, more amateur naturalists, a society "for mutual help between them and the professional scientists"—the original project of the British Association; a journal more suited than NATURE to their needs; museums like those advocated by Flower fifty years ago, and locally realized. Will Dr. Baker take a hand in the museum at Oxford?

But all these enterprises imperil the Cynic seclusion of potential discoverers. Either they must be left to chance-and-genius, like scientific discovery, or somebody must attend to them; and this means planning such applications of science; the maintenance of an "environment in which culture is respected" (p. 139); the "elimination of snobbery"—of homage to political influences, "progressive" or otherwise; and, most important of all, the replacement of one generation of men of science by another, through scientific teaching. "Already the majority of research workers spend a large part of their time in teaching, or in other work in which complete freedom is impossible" (p. 50), and Dr. Baker's planning seems likely to diminish their freedom. It is all very sad; the best we can do is to "keep out of the sunlight" of the Cynic who comes in our way, and encourage the "progressive classes" to do the same.

JOHN L. MYRES.

PHYSIOLOGY OF VISION

Vision

A Study of its Basis. By S. Howard Bartley; with an Historical Perspective, by Edwin G. Boring. Pp. xv+350. (London: Macmillan and Co., Ltd., 1941.) 18*s*. net.

AFTER a period of stagnation, the last twenty years or so have seen a remarkable revival of research into the complex and difficult problems of the fundamental physiology of vision. During this time great advances have been made in our whole conception of the state of adaptation of the eye, in our knowledge of the photochemical and electrical changes which take place in the retina and optic tract in response to stimulation by light, as well as of the correlations between different types of stimulus and the sensations produced. There has lately been an urgent need for a book, possibly on the lines of the "Recent Advances" series, which would make the results of modern research more generally available, and would, perhaps, show how such apparently separated subjects as, for example, the photochemistry of the retina and the study of visual sensation under different conditions can be brought together to build up a coherent picture of our present ideas about the processes whereby light, falling on the eye, produces the complicated visual sensations of which we are conscious.

No one who has tried to produce for students a clear picture of our modern outlook on visual mechanisms can fail to welcome Bartley's book. The author has very decided views on the way in which the problems of vision should be approached, and, because his book reflects them so strongly, he is likely to meet with a good deal of disapproval from many, if not most, experts in the subject. Bartley believes, if I read him rightly, that work on vision should approach the subject through the study of sensation rather than via the chemical and other reactions of the retina. He points out, quite rightly, that the final results of stimulation of the eye depend on the characteristics of the whole optic pathway, from the end-organs in the retina to the visual cortex, and that explanations of visual phenomena based on the behaviour of visual purple and the rods and cones of the retina, such as those produced by Hecht, are bound to be misleading. The author's insistence on the inadequacy of this point of view is timely and necessary; but, unfortunately, he has gone too far in the other direction and has, in consequence, produced a book which is, itself, both misleading and one-sided. This is a great pity since he undoubtedly spoils the force of a valuable argument by minimizing, and often altogether ignoring, much important work.

It is certainly true that the Duplicity Theory—which associates day-vision with the retinal cones and night-vision with the rods and visual purple—no longer provides a sufficient explanation of all the phenomena, but this does not detract from the importance and validity of the facts on which the theory was originally based, as well as of recent results which support it. Completely to ignore this body of knowledge, as the author does, in a discussion of dark-adaptation, for example, cannot, to put it mildly, really help in the clarification of the problem. Any consideration of the problem of vision as a whole must include the question of how light is able to initiate nerve impulses as well as how these impulses give rise to conscious sensations. Light energy must act through the medium of photochemical substances, and to ignore all that is known of at least one such substance in the retina is surely odd in a book the title of which is "Vision: a Study of its Basis".

The greater part of the book deals with recent work, much of it the author's own, on sensation. The chapter on the visual perception of movement is particularly valuable, both for its description of experimental work and for its theoretical discussion. There is also a very interesting discussion of the dependence of visual acuity on changes in illumination. The author points out the difficulties in the way of reconciling present-day theories of the effects of raising the illumination on interaction between different parts of the retina with the fact that increased illumination undoubtedly also increases visual acuity. In this connexion, it is a pity that he seems to be unaware of Polyak's recent work on the micro-anatomy of the primate retina, because this worker's demonstration that only some of the retinal cones bear a one-to-one relationship to their optic nerve fibres should help to elucidate this particular problem.

It is good to find, at last, a comprehensive account of the work on the electrical changes in the retina and optic nerve in response to light. Great advances have been made in this subject recently and results of considerable interest, not only from the point of view of vision but also of sensation in general, have been obtained; and Bartley's account is, on the whole, a clear and full one. One cannot, however, help but deplore the fact that his suspicion of photochemical explanations of retinal activity should have led him to omit any reference to the formidable body of evidence produced by Granit and his colleagues to associate the *b* wave of the electroretinogram with the presence or absence of visual purple. In this section, also, very much less than justice is done to Hartline's truly exquisite work on the electrical responses of single optic nerve fibres—work which has been of so much value in helping us to understand the reactions of this nerve as a whole to stimulation.

It is probably true that attention has lately been too exclusively directed towards the retinal end of what might be called the visual chain, and that the author's contention that we can now learn more about vision by studying the physiological psychology of visual sensation rather than the details of retinal activity should, therefore, be seriously considered. Those who wish to learn more about recent developments on these lines will certainly find his book extremely useful and satisfying.

KATHARINE TANSLEY.

INDIAN FOREST UTILIZATION

Manual of Indian Forest Utilization

By H. Trotter. Pp. x+419+18 plates. (London: Oxford University Press, 1940.) 30*s.* net.

THE embarrassing richness of well-forested tropical countries is in itself a handicap to the economic utilization of their timber resources. It is no easy task to select from some hundreds of different timbers those which are most suitable for each particular purpose; instead, the usual practice has been to concentrate on a small number of primary hardwoods which have been found by experience to be durable and generally suitable for everyday needs. This works very well so long as these timbers are plentiful and cheap, but there comes a time when the demand overtakes the supply, prices soar, and it becomes necessary to turn to the lesser-known woods which make up the bulk of the country's forest resources. This was roughly the position in India twenty-five years ago. The timbers most in demand for ordinary purposes were about a dozen in number, among which teak (*Tectona grandis*), sal (*Shorea robusta*), and deodar (*Cedrus deodara*) were pre-eminent. Shortly before 1914, the inevitable began to happen; as a result of the World War, the demand for timber rose with alarming rapidity and the study of the secondary timbers of India was taken up in earnest.

The present War finds other parts of the Empire in somewhat the same position as India was twenty-five years ago; in some cases their state is worse, because of the quantities of Baltic and North American softwoods which they have been importing while their local timber supplies remain undeveloped. Without necessarily taking Indian practice as a model, these countries may still learn much from India in forest utilization.

In the volume under review, the important question of replacing the relatively scarce standard timbers of India by others in more plentiful supply is tackled in commendably practical fashion. The principal uses of wood are dealt with in turn and the chief requirements of a timber for each particular purpose are clearly stated. Timbers for bridge-building, to take a simple example, require to be strong and durable. A descriptive list of representative timbers suitable for this purpose is followed by a table of relative strength values, as a guide to anyone seeking the best structural timber in his particular district. Under the heading of vehicle construction the essential characteristics of timbers for the framework, axles, hubs, spokes, felloes, etc., are set out, and suitable species are recommended for each part. The manufacture of matches is an example of a highly developed timber-using industry which is very exacting in its demands. Strange though it may seem, there are very few woods really good for making match splints and match boxes. Analysis of the requisite properties, however, shows how strict is the specification for a timber which will compare with imported aspen, the match wood *par excellence*.

The way in which standards of quality are determined by the materials available is strikingly illustrated in the case of joinery timbers. The outstanding characteristics of an acceptable timber in this class are that it should be cheap, plentiful and not too hard to work. In Europe and North America, the so-called softwoods (pine, spruce, fir, and other coniferous woods) have long since taken the place of oak for three quarters of the joinery work. In the greater part of India, however, conifers are not easily available and the joiner is accustomed to use hardwoods, some of them so hard that they would be regarded with horror by his opposite number in Europe. The greater labour in working hardwoods is offset by their superior strength and lasting qualities, which render them more suitable than softwoods for work of a permanent nature, especially in the tropics. It is unfortunate that the prejudice in favour of softwoods has spread from Europe to many parts of the tropics before local timber resources have been developed sufficiently to hold their own. The imported softwood has the advantage that it is well sawn and seasoned ready for use—an important consideration to the contractor; on the other hand, it is not very resistant to the fungus and insect pests which attack timber in tropical climates. In every forested tropical country there are indigenous hardwoods which are known to be superior to softwood, and it should only be a matter of time before they replace the imported material. It is essentially a matter of organizing local resources.

The chapter on the uses of wood from which examples have been taken is an admirable summary of the technical data on individual timbers accumulated in the records of the Forest Research Institute, Dehra Dun. The other chapters dealing specifically with timber cover the structure and properties of wood, felling and conversion, transport, storage, and the important auxiliary industries of seasoning, preservation and wood-working.

A substantial portion of the book is devoted to the so-called minor forest products which are of such enormous economic value to India. Some of these are the basis of important industries: lac, turpentine and rosin, charcoal, and paper pulp, for example, are each given a separate chapter. Others are conveniently classified under half a dozen headings as fibres and flosses, drugs and spices, oilseeds, distillation products, tans and dyes, etc. Many of these commodities are the subject of monographs, but so far as I am aware, there is no single volume readily available which covers the whole field. This part of the book, therefore, will be of particular interest to anyone seeking a brief elementary account.

Of the book as a whole it may be said that the author has given the reader what he wants to know in a form in which he can easily utilize it. The preface states that it is intended primarily as a text-book for Indian forest ranger students, but there can be no doubt that it will also be welcomed by senior officers of the Indian Forest Service and will be found useful for reference by a wider circle of readers. It is only to be regretted that the author has not seen fit to include at least a short bibliography of forest department publications and other more exhaustive works which the reader may wish to consult for fuller details.

B. J. RENDLE.

EDUCATION AFTER THE WAR

By M. L. JACKS

Director of the Department of Education, University of Oxford

THERE are to-day signs of intense activity on the whole educational front, and local advances are being planned and discussed and sometimes put into execution on many sectors. This movement is to be warmly welcomed, but it has in it certain dangers: of these the chief is that it is largely an unco-ordinated movement. This may be inevitable at the present stage of development, but it is a feature in the situation which should be brought to an end at the earliest possible moment. Until the campaign can be seen as a whole and a proper strategy worked out for carrying it to a successful conclusion, there is a grave risk of our frittering away our forces in tactical advances which are of no ultimate value, in concentrating our strength at one point and weakening it at another equally vital, and in occupying positions which are only tenable (and indeed only worth holding) if an advance is made along the whole line. It is to this advance of the whole line towards a comprehensive objective that we must devote our attention. *Quo vadimus?* In this article I shall endeavour to set up three direction posts and to indicate briefly to what they point. To drop the metaphor, I shall suggest three general principles which should guide our planning of post-war education, and apply them to certain practical problems.

My first principle is the principle of *wholeness*—the wholeness of the child, and the wholeness of his educational experience. Education viewed from this angle might be described, on the analogy of total war, as *total education*, and those who care to work out the analogy will find in it much that is suggestive and helpful. It has not been our custom in the past to educate our children as integrated wholes: our tendency has been rather to analyse them into wholly artificial parts, and then to try to educate these in isolation from one another. Thus we have adopted a tripartite division into body, mind and character, which has become traditional: the body we have educated (or rather exercised—by no means the same thing) on the playing-field, the mind in the class-room (and for many this has comprised the whole of education), and the character in the give-and-take of school life; there has been little deliberate effort to educate the will or the emotions. The result has been that not only have we failed to educate the whole man and have turned out from our schools those unbalanced personalities which are such a danger both to themselves and to their fellows, but we have also not even succeeded in educating any one of the three parts; for the truth is that we cannot educate one unless at the same time we educate all the rest. "A teacher comes to grief", says Prof. Whitehead, "as soon as he forgets that his pupils have bodies."

Education, if it is to be effective, must always mean the co-education of all parts of the human personality. To take a particular illustration, physical education can never be an end in itself or limited in its objective to the body; to demand this, and to make a meaningless 'physical fitness' our end, is self-defeating. Physical education means the education of the whole man through his body, a truth of which Plato was aware when he said that "Gymnastic" was primarily for the soul. To act on this principle of wholeness will clearly mean considerable changes in our choice of subjects and in our methods of teaching them; we shall have to make a deliberate attempt at synthesis in constructing our time-tables and in organizing our school-life, so that a day at school may become a piece of intelligible tapestry instead of the patchwork quilt which it so often is. We shall have to change our very conception of a 'subject', and perhaps give up the use of the term (and a good riddance), substituting for it the conception of an activity, and the activity of a whole human being. This human being, moreover, is a whole *now*, and there is a wholly right life for him to live to-day; to provide that life is to educate him: education is not a preparation for something else, for a distant and uncertain future, for earning a living or citizenship or life, but is a whole life (and a different life) to be lived by each child here and now; out of that life the right future will develop as the flower from the bud.

Moreover, the process must cover the whole period of childhood and adolescence; up to the age of eighteen (at least) the boy must be subject to educational authority, and if he leaves school for part-time employment in a factory at fifteen or sixteen it must be because it is there that his education can best be carried on. This is very different from the continuation school plan, under which a controlling industry will let off an employee for so many hours a week to continue his education. Industry can play its part by friendly co-operation with the school, by stressing the educative side of its young employees' work, and perhaps by the establishment of works' schools. Such an educational scheme implies a social revolution; but education and society are so closely interwoven that the revolution which we all see to be necessary in one cannot be carried out without a parallel revolution in the other.

So much for wholeness. My second principle is that of *comprehensiveness*. The connotation of the word 'education' has immensely widened since the days when it stood for little more than the three R's, and it is widening every day. We now know that education means much more than teaching even a vastly increased range of subjects; it means the provision of everything a child needs for the discovery and full development of all his potentialities—physical, intellectual, emotional, moral and spiritual. Nutrition and health, milk and meals, rest and sleep, cleanliness and clothing, the encouragement of aptitude and creative skills, the growth of emotions into valuable sentiments, training of the æsthetic sense and of social attitudes, vocational guidance; all these are properly part and parcel of the educational process for *all* boys and girls, and not only for those who, by reason of home circumstances, seem to stand particularly in need of them; it is very often those who seem to need them least who do in fact need them most, and none of these elements in the educational process must be tarred with the brush of State-charity.

There must be, moreover, a new marriage between the cultural and the technical, and that false and unfortunate dichotomy must be ended in a new conception of twentieth-century culture. The old dividing line between a 'liberal' and a 'vocational' education (never a very clear one) must be erased wherever possible, and we must so teach our more specifically cultural subjects that their vital relationship with the technical may be recognized, and so teach our more specifically technical subjects that their full cultural possibilities may be realized. The curriculum, moreover, must be widened. There has been a rapid movement in this direction during the past thirty years, a movement to which evacuation experiences have given an added drive; many schoolmasters, evacuated to a new environment and compelled by the exigencies of war to devote the time of their pupils to activities which have never hitherto fallen within their purview, have found, to their surprise, that these activities are often more educational than the class-room subjects whose time they have usurped. It is to be hoped that this lesson of evacuation will never be forgotten. But a wider curriculum can only be maintained if it is accompanied by greater freedom of choice on the part of the boys and girls for whom it is provided. We need a much greater variety in post-primary education, whether this takes the form of a greater variety of schools or a greater variety of 'sides' within the same school. I can visualize a post-primary education in the future of which the staple constituent will be book-learning as in the secondary school with which we are familiar, and at the other end of the scale an education in which book-learning will be almost non-existent, with infinite gradations in between: I visualize schools which are more like clubs, new types of boarding-schools (on the lines of the present camp-schools), schools which are day schools up to a certain age and boarding-schools beyond that, and many other varieties. Only in such a variegated field shall we be able to attain that 'equality of opportunity' in education which is to-day a popular slogan, but like most slogans very ill-thought out. It does not mean equality of opportunity to attend a certain type of school enjoying a fictitious prestige, or equality of opportunity to go to the university. It means that every child should enjoy an equal opportunity with every other child to receive *the right education for him*, and that means that we must have available types of education to meet the needs, intellectual, moral, physical, and spiritual, of all children.

My third and final principle is that, in a far more real sense than ever before, *the schools should serve the community, and the community the schools.* The community demands that the product of education should be the good citizen; the individual demands the development of a unique personality. These demands are often regarded as contradictory; they are in fact complementary, for the fully developed individual is the life-blood of democracy, and the best citizen is the man who has been given the opportunity, and has taken it, to become his best self. This truth is more likely to be appreciated, and the duty of the community to the school and of the school to the community is more likely to be performed, if there is a much closer association between the two. On one hand there should be no schools outside the national system. This does not mean standardization, or the reduction of all schools to the dead level of the few categories which we know; for the national system itself is capable of expansion to embrace a much wider variety of schools than it does to-day, and there should be room within it for all those diversities of educational life and experiment represented by schools which are at present independent of public support: given public support, they must, of course, be open to all who can profit by the education they offer, and our ideal should be schools common to all classes but diversified in type.

The two essential freedoms to safeguard are the freedom of the parent to choose his child's school, and the freedom of the school to choose its pupils, both freedoms being exercised within wide limitations. This association between school and community can be further fostered by the encouragement within the school itself of realistic social studies. I do not mean by this courses in civics or current affairs, though these may have their importance. But citizenship is best learnt by practising it within the school community, and its significance can best be appreciated by the study and use of the community immediately outside the school walls. The locality should, in fact, be the first text-book of every school. If that can be done, there will be less danger of that community-sense which many of our schools foster (and particularly our boarding-schools) stopping short, as it so often does, at a school-community-sense, and a bridge will be built (one of the most difficult bridges to build) between school and 'real life'. That should be the beginning of an outward movement which will end in the world-community claiming the allegiance of the world-citizen.

Finally, the 'walls of partition' must be broken down from the outside as well as from the inside, and if the school is to go out to the community, the community must come into the school. To some extent this is being done, and it is symbolical of the change that, whereas in the nineteenth century schools were surrounded by high walls and locked gates, to-day they are commonly built open to the streets and the gates are rarely shut. But the flow of traffic through this open gate is not yet as free as it should be. There is no reason why the industry and the craftsmanship of the neighbourhood should not find their way into the classroom and display their wares and expound their ways of life there—invaluable recruits to the teaching profession; there is no reason why other recruits should not be found among representatives of the local authority and of the professions; there is no reason why the schools themselves should not become community-centres for education, providing classes and courses and cultural activities for children in the day-time and for their parents in the evenings. In these ways social studies would become a real and vital element in the curriculum, and the association between school and community would be complete.

Much has necessarily been left unsaid in this article. No mention has been made of the universities or of adult education: the whole field of religious education has been left unexplored—if explored, it would be found to affect profoundly not only the curriculum, but also the whole organization and administration of the school; and nothing has been said about the training of teachers or the relationship between teaching and other forms of youth service. But I hope I have succeeded in erecting certain pointers to the education of to-morrow.

STRUCTURE AND ROTATION OF GALAXIES

A SUCCESSFUL and well-attended symposium on the structure and rotation of our own Milky Way system and of external galaxies was held at the rooms of the Royal Astronomical Society in Burlington House on July 10.

The discussion opened with a contribution by Dr. A. Hunter on interstellar absorption and the scale of the Galaxy. Pointing out that the absorption produced by interstellar matter is important in studies of galactic structure because of the effect which it may have on estimates of stellar distance, Dr. Hunter went on to review modern methods of determining great distances in astronomy. Except within about a hundred light-years of the sun, the distance of a star is found by comparing its apparent brightness with its true brightness, this latter being estimated by physical examination of the star's light. The distance then follows by applying the inverse-square law. If this law does not hold, however—if, for example, we attribute wholly to the effect of distance dimming which is partly due to absorption—we shall over-estimate distances by amounts which may be very serious if the absorption is heavy. In the past decade many attempts have been made to determine the absorption in various directions. Nearly all depend on comparing photometric distances of distant objects determined as outlined above with distances inferred by geometrical means. Trumpler, for example, arguing that the diameters of physically similar clusters ought to appear smaller in proportion to their distance, found that distances so estimated could only be reconciled with photometric distances by assuming an average absorption of 0·67 stellar magnitudes for every thousand parsecs.

Other work on broadly similar lines has more recently led to much the same result for observations made close to the galactic equator. Hubble's results on the dimming of extra-galactic nebulæ by absorption in our own system suggest that the obscuring matter is confined to a thin layer fairly close to the galactic plane. Meanwhile, spectroscopic observations of interstellar reddening in the light of distant objects of all kinds have been made by photographic and photo-electric means. Coefficients of this selective absorption depend greatly on galactic latitude and longitude, the reddening being greatest at low latitudes and towards the galactic centre. The correlation with distance is very rough, but the value of the mean coefficient taken around the galactic circle suggests that only about one third of the total absorption is selective. Our present picture of absorbing matter in the Galaxy is one of irregular clouds close to the plane of the Milky Way superposed on a thin stratum which dims the light of stars in and behind it according to a cosecant law down to a galactic latitude of 10° or so. Less than half this absorption is selective, the reddening caused by this part being due to particles scattering according to a λ^{-1} law; the rest is non-selective blocking, presumably by larger particles. The stratum extends to at least 2,000 parsecs from the sun, but we cannot say that it necessarily permeates the Galaxy: it may be (to this extent) local. The irregular obscuring clouds closer to the plane of the Galaxy produce heavy absorption and reddening. The recognition of this absorption during the last decade has roughly halved our estimate of the size of the Galaxy and thus incidentally brought it more nearly into accord with that of other giant systems.

Dr. H. Brück, in a contribution on the structure of the Galaxy with special reference to the neighbourhood of the sun, took up the question of the interpretation of star-counts made up to distances of about 2,000 parsecs from the sun. The density function derived from these data, assuming the form of the luminosity function (which is fairly well known), depends greatly on the value assumed for the interstellar absorption. Away from the galactic plane the absorption is small and interpretation is not difficult, but close to the galactic equator the analysis becomes less and less easy. If the absorption is assumed negligible, the well-known Kapteyn universe results, with the sun central in a universe of stars the density of which falls to 10 per cent of its central value at 500 parsecs along the axis of symmetry of the Galaxy and at 3,000 parsecs in its plane. Charlier's "local cluster" of *B* stars, with the sun eccentrically located 70 parsecs from the centre of a flattened system 700 parsecs in diameter and 250 parsecs thick, is now regarded as only the nucleus of a much larger cluster associated with Gould's belt. This cluster may itself be one of many star clouds which constitute the Galaxy as a whole; certainly the observations of galactic rotation prove conclusively that the sun is located at least 8,000 parsecs from the galactic centre. The steep negative density gradients of Kapteyn's universe cannot be eliminated by the assumption of a constant coefficient of absorption: if the absorption postulated is big enough to give constant space densities out to 1,000 parsecs, then rapid rises which are quite unlikely set in farther out.

The compromise due to Bok, who uses a coefficient of 0·4 mag./kpc., yields a density distribution which is roughly constant up to 1,000 parsecs in directions perpendicular to that of the galactic centre, which decreases rapidly towards the anticentre, and which first decreases (100–800 parsecs) and then rises again towards the centre. This tentative picture of a local system elongated at right angles to the direction of the galactic centre tempts us to believe that the sun is situated in a spiral arm of the Galaxy; but Oort's work leads to a very different conclusion. This is based on observations of stars of the 10th to 17th magnitude in galactic latitudes higher than 10°, and is thus independent of the worst irregularities due to absorbing clouds nearer the equatorial plane. On the basic assumption that all absorption has occurred before the mean distance of the 10th magnitude stars, Oort finds that the sun is in a region of low density surrounded in all galactic longitudes by higher densities. The suggestion here is that of a 'local void' between two spiral arms rather than a local cluster, and discrimination between the two hypotheses must await further observations.

Sir Arthur Eddington then gave an account of our present knowledge of the rotation of the Milky Way. The effect of galactic rotation is observable both in the radial velocities and in the proper motions of the stars, but the data from which its amount is determined are in fact confined to the radial velocities, the proper motions providing only confirmatory evidence. In the neighbourhood of the sun, the planetary-type motion distorts a cube of stars into a rhomboid by an action analogous to a shear; differential motion is then observed between the faces of the cube, and terms of the form $Ar \sin 2(l-l_0)$ are necessary to represent the observations. The rotational constant A is about 17 km./sec. per kiloparsec. The actual rotational velocity in the neighbourhood of the sun is obtained from radial velocities of distant clusters: it amounts to 250 km./sec., the distance to the centre of rotation being 10,000 parsecs (this agrees well with Shapley's figure when interstellar absorption is taken into account), and the total galactic mass being roughly 10^{11} times that of the sun. The time of one complete rotation is about 250×10^6 years, a figure which has remained unmodified since the pioneer work of Lindblad and Oort.

The observations of galactic rotation throw some light on the question of the reality of the local cluster discussed by Dr. Brück. Rotational shear in such a cluster would be expected to spread it into a ring—certainly a cluster having the shape of a flattened ellipsoid of revolution would be unstable in a rotating galaxy. This objection is quite independent of theory: it is an observational fact that shear exists in the neighbourhood of the sun, hence that any local cluster must be at best a transitory phenomenon. This view is supported by observations of the cosmic cloud. The interstellar atoms and molecules responsible for stationary lines in stellar spectra are widely distributed throughout the Galaxy and show the same galactic rotation effect as the mean of the stars. It can be shown that these interstellar particles must move with velocities corresponding to circular orbits, otherwise impossibly large density gradients would be set up; hence the stars, too, are so moving, and any local cluster could not persist. From this point of view Sir Arthur welcomed Oort's hypothesis as a way of avoiding the dynamically unstable singularities involved in the hypothesis of a local cluster.

The discussion was wound up by the Astronomer Royal, Dr. H. Spencer Jones, who took as his subject the rotation of extra-galactic nebulæ and their internal distribution of mass. Pointing out that the planetary-type rotation described for our own Galaxy by Sir Arthur Eddington referred only to the solar neighbourhood, presumably at about 10,000 parsecs from the centre, Dr. Spencer Jones turned to spectroscopic observations of the rotation of other galaxies. These referred until recently only to the bright central portions of such objects as *NGC* 4594 and 4111, the rotation of the nuclear regions of which is of the 'solid' type giving constant angular velocities.

Within the last few years, however, work at the Lick Observatory has made available rotational velocities for the Andromeda nebula (*M* 31) and *M* 33 out to considerable distances from their centres. The results of Babcock for *M* 31 show a period for the core of 11×10^6 years, and for the main body of 92×10^6 years, and indicate that much of the mass is in the outer regions. In *M* 33 Mayall and Aller find that the velocity increases at first linearly with radial distance from the centre, then faster until at the edge of the main body a maximum velocity is reached corresponding to a rotation period of 59×10^6 years. In the outer parts the velocity decreases again, the corresponding periods varying from 60 to 200×10^6 years. In these regions Oort's rotational "constant" *A* varies from 84 km./sec./kpc. at 1,280 parsecs from the centre to 30 km./sec./kpc. at 1,920 parsecs, a rough extrapolation indicating that at about 2,200 parsecs conditions of rotation similar to those in the solar neighbourhood would be reached. This in turn indicates that if *M* 33 and our own Galaxy are comparable bodies, the sun is at a distance from the centre of at least twice the radius of the main body, and that from an external galaxy the main body would appear only about 8,000 parsecs in diameter, the sun being well beyond this in the thin outer regions. The observed distribution of rotational velocity in both *M* 31 and *M* 33 can be adequately represented by a thin-disk model, possessing circular symmetry, the individual parts of which revolve in circular orbits about the centre in the plane of the disk. Assuming that in such a disk the surface density can be expressed as a fifth-degree polynomial in the distance from the centre, Wyse and Mayall have determined the curves of force and thence of rotational velocity for typical disks. Then by working backwards they deduce the density distribution in *M* 31 and *M* 33 necessary to fit the observed velocity curves.

A wide distribution of mass throughout both systems is indicated, little tendency being found towards the central condensation usually postulated for our own Galaxy. In *M* 31, for example, the model of best fit consists of two concentric thin disks, and indicates that less than 1 per cent of the mass is contained in the central regions. The total mass is $9{\cdot}5 \times 10^{10}$ suns, which agrees well with that of the Galaxy. A rediscussion of Oort's constants of galactic rotation shows that the information they yield concerning the distribution of matter in the Galaxy, while consistent with strong central condensation, does not lead uniquely to such condensation. It may well be, then, that the mass of the Milky Way system resides largely in its outer regions, in which the sun lies. The question then arises, Why should the brightness of a galactic system be so much less in the outer regions than near its nucleus? Can it be that the luminous giant stars occur near the centre while dwarfs tend to preponderate in the outer regions; or is non-luminous dust so widespread round the periphery that it contributes much of the total mass of the Galaxy? These and many other questions of galactic structure must await further observations in happier times.

A. HUNTER.

BRITISH ASSOCIATION CONFERENCE ON MINERAL RESOURCES

THE Conference on Mineral Resources and the Atlantic Charter, held at the London School of Hygiene and Tropical Medicine on July 24–25, was convened by the British Association Division for the Social and International Relations of Science and, like the recent conference on agriculture, owed its origin to suggestions made at the Conference on Science and World Order held last September. The fourth clause of the Atlantic Charter promises equal access on the part of all peoples to the natural resources of the world, and as minerals are among the most important of those resources, it was felt that a survey of the situation might clarify ideas; the general state of information as to the distribution and nature of mineral deposits among the public and even, it is to be feared, in higher quarters, being very imperfect. Coal and oil were excluded from the scope of the discussion as requiring separate treatment. Those who have had occasion to examine questions concerning mineral deposits have been impressed by the unsatisfactory condition of the statistical knowledge about them which is available, in spite of excellent isolated efforts, and for that reason prominence was given to this aspect in the resolution which was put by Sir Stafford Cripps and passed at the end of the Conference. After a preamble referring to the Atlantic Charter, this ran:

"This Conference, having specifically dealt with mineral resources, submits that, as a first step, the Council should initiate forthwith consultations with appropriate scientific and technical organizations, to secure an understanding on the principles involved. The Conference would further urge that a scientific review of mineral resources, using and supplementing all existing data, should be among the first tasks of any international organization for the social applications of science, such as was envisaged at the recent Conference on Science and World Order. To this end, the Conference recommends that the Council should consider how it might help to promote the establishment of an International Resources Organization, as a fact-finding and advisory body for Governments, as a contribution to world stability, and in the spirit of the Atlantic Charter."

The Conference, which was well attended, was opened by the president of the Association, Sir Richard Gregory, who referred briefly to the new industrial revolution brought about some sixty years ago by the introduction of alloy steels, bringing unfamiliar metals into prominence; metals which are most unequally distributed in the crust of the earth, and thus having special significance in the light of the Atlantic Charter. Sir Thomas Holland, whose presidential address at the South African meeting of the Association first directed attention to the international importance of this irregular distribution of economic minerals and its bearing on preparations for war, then took the chair.

As examples of the questions to be considered, Sir Thomas Holland mentioned that the United States, with its vast steel industry, consuming 750,000 tons of manganese ore in 1937, was unable even with the help of a 100 per cent protective tariff to produce from home sources more than 5 per cent of her own requirements. Germany, also lacking manganese. was tempted by the great resources of South Russia in that metal, perhaps more than by petroleum, Great Britain was almost self-sufficient for the few and simple essential constituents of steel until the last quarter of the nineteenth century, but found itself dependent on distant parts of the Empire and on foreign countries for the alloying elements now needed. Unlike some other natural products, metals cannot be made synthetically for industrial use, and although for certain minor purposes they may be replaced by plastics, they remain indispensable to industry. This dependence necessitates the international exchange of minerals, and if this is to be facilitated, as it must be in a peaceable world, the knowledge of their distribution must be both more complete and more widely diffused.

Prof. H. H. Read, after apologizing to the many geologists present for his elementary treatment of the subject, gave a lucid account of the geological conditions which determine the distribution of mineral deposits. National boundaries have paid little attention to geological regions, and impossible demands for autarky have been made by dictators ignorant of their countries' geology. An autarky based, like that of the U.S.S.R., on a proper estimation of native resources is one thing, and an autarky based on legislation quite another. Even such a wide grouping as that of the United Nations is not completely self-sufficient in minerals, and still less any single country, however extensive.

It was natural that several of the speakers, who had prepared their papers independently, should select the metals used in the production of alloy steels as typical illustrations of irregular distribution. Prof. C. B. Fawcett, speaking of key metals and the location of industry, pointed out that these exceptional elements, such as tungsten, molybdenum and vanadium, are mainly found in the older rocks and for the most part in thinly populated areas. The quantities required are small in proportion to the tonnage of steel produced, and it is also characteristic of them that they pass entirely into the finished product, the loss in manufacture being almost negligible. Many of them occur in such a form that the ores have to be submitted to some kind of concentration before extraction. They are mainly consumed in the regions where heavy industries of the more advanced type are situated; industries employing much skilled labour. These are usually regions of long-established industry, and the gravitation to them of the key metals tends to confirm the existing location of those industries. A dominant fact is that they are essential to the production of armaments and to the making of tools used in that production, so that under existing political conditions no State can feel secure unless it has within its borders a considerable armaments industry. The importance of recovered or scrap metals, dealt with by later speakers, further tends to anchor the highly developed industries to their existing locations.

Prof. P. G. H. Boswell, dealing with the need for better and more complete statistics, reviewed the available sources of information and referred to the lack of uniformity in the definition of available resources. Much information about known resources and estimated reserves is locked up in the archives of mining companies, and it is a question how far this may be made available. An international commission seems to be the only body which could undertake the work after the War, and a useful beginning could be made even now if finance were provided. Exploration has now covered the greater part of the earth's surface, at least so far as the commoner minerals are concerned, but China still affords a vast field for further exploration, while the search for the rarer elements has been far less thorough.

Prof. Boswell concluded with a warning that the diversion of many geologists during the War to other activities, coming after a period in which the number of men being trained in geology was declining, may lead to a serious situation. British geologists have played a leading part in exploration, and many of the leading geologists of other countries have received their training in Great Britain; the lack of appreciation of the importance of the subject, due to ignorance, calls for the attention of educational authorities. After the War, it may be necessary to provide geologists not only for our own needs, but also for loan to countries where scientific training has been interrupted or destroyed. In the course of the discussion it was suggested that geologists might be attached to legations in the lesser-known countries.

The afternoon session on July 24 was presided over by Sir William Larke, who also emphasized the need for a uniform basis for statistics and the fact that in spite of the British lead in scientific discovery and technical achievement, the nation as a whole lacks appreciation of the value of research. The need for continued inter-allied co-operation in this field and in that of economics was stressed. He alluded to the growing importance of the light metals and to the possibility of extracting aluminium from clay, thus rendering the industry less dependent on the very local distribution of bauxite. The high consumption of power in aluminium production would seem to determine the location of the industry, although for reasons partly economic and partly strategic Germany has built up an important aluminium industry based on electric power generated from brown coal and largely imported bauxite. Like other speakers, he referred to the key nature of the less common metals, large stocks of which had been accumulated by Germany before the War, while no doubt much has been done to conserve those resources by changes in the composition of alloys and in technique.

The remainder of the session was taken up by papers illustrating the general principles by reference to particular metals. Prof. W. R. Jones selected tin, the occurrence of which in useful quantities is confined to a very few regions. The United States consumes 40 per cent of the world's tin, but has not a single tin mine within its borders. Europe provides only 1 per cent of the world's output, this coming mainly from the anciently worked Cornish mines. The alluvial deposits which were the principal source of tin are being rapidly worked out, and we shall in the future be more and more dependent on lode mining. The conditions for the formation of lodes are confined to a few of the older rocks. More efficient concentration of the ores will become important.

Closely allied to the occurrence of tin is that of tungsten, the position of which was outlined by Mr. J. L. F. Vogel. The geological conditions of the deposition of tungsten ores are such that no mining engineer would venture to predict the quantity to be found in a newly discovered deposit. The metal was actually the first to be used in the production of an alloy steel, Mushet having introduced it into his improved tool steel, and it was the main constituent of the high-speed tool steels which attracted so much attention at the Paris Exhibition of 1900. Until 1914 the production of the metal was mainly in Germany, although much of the ore occurs within the British Empire, but since then it has been produced at home.

Manganese ores, which are essential to steel making, were dealt with by Sir Lewis Fermor, who said that whereas manganese is only present in the earth's crust to the extent of 0·10 per cent of the oxide, the ores which are used as its source contain 40 per cent or more of the metal. Of the producers, the U.S.S.R. accounts for well over one-half of the world's supply of almost five million tons, India ranking second. The geographical distribution of this and other economic minerals was illustrated by maps showing the extent of the former continent of Gondwanaland. Ninety per cent of the total production of manganese is consumed in the iron and steel industry, and no satisfactory substitute for it has been found. The paper contained a number of valuable tables, and it was argued, on the basis of statistics of imports and exports, that the Axis countries had no real grievance in respect of supplies of manganese ore. Whereas they produced less than 2 per cent of the total, the pre-war system of international commerce allowed them to secure 26 per cent of the available exports, or 16 per cent of the world's production.

Nickel was discussed by Lieut.-Colonel the Hon. Colin A. Campbell. The greater part of this metal is also consumed in the iron and steel industry, for which it is essential for many purposes, including the stainless steels. Its occurrence is extremely restricted. The first extensive production was from New Caledonia, where it was discovered fifty years ago. The ore, garnierite, is a silicate. The far more extensive deposits of Sudbury, Canada, where the ore is a sulphide associated with copper, were discovered in 1887 and now provide 85 per cent of the total production. The other deposits of the world were reviewed, and even allowing for the opening up of new mines, it seems likely that Canada will account for 80 per cent of the total during our lifetime. The demand is certain to increase as the area of industrially developed countries is widened and their standard of living raised. Its extensive use in armaments gives it high importance in any scheme of sanctions against aggressors.

The last metal dealt with in the session was aluminium, a paper on which was contributed by Mr. M. P. Fogarty. The world output of virgin aluminium was approximately doubled between 1937 and 1941, reaching just under a million tons and it may reach 1,750,000 tons by the end of this year, mainly owing to large extensions in the United States. Secondary aluminium recovered after use is now also an important factor in the industry. The paper dealt largely with the British industry after the War, and contained many statistical data and tables. The utilization of aluminium for civilian purposes has not proceeded so far as might have been expected, but its development is likely to be resumed as soon as the large amount consumed in the aircraft industry is released. An interesting review of new technical methods of utilizing the special qualities of the light alloys was included in the paper.

C. H. DESCH.

(To be continued.)

OBITUARY

Mr. G. C. Lloyd

MR. GEORGE CHRISTOPHER LLOYD, secretary of the Iron and Steel Institute during 1909–33, who died on July 10 at the age of eighty-one, was trained as an engineer, and after completing his apprenticeship spent some years with the Spanish Compañia Transatlantica. He had been at school in Germany, and the knowledge of languages which he gained in his studies and travels was a great asset to him in his later activities.

After a period in a firm of consulting engineers, he joined the staff of the Iron and Steel Institute as assistant to the secretary, but four years later left to become secretary of the Institution of Electrical Engineers. On the death of Mr. Bennett H. Brough he returned to the Iron and Steel Institute, which he served efficiently and devotedly for twenty-four years. Through the foreign meetings of the Institute he made friends among the metallurgists of many countries and was associated as secretary with several international congresses, being a vice-president of the International Association for Testing Materials. His services in this field were recognized by the conferment on him of the Swedish Order of the North Star and of the French Legion of Honour.

In 1915 he was also appointed secretary of the Statistical Bureau of the Iron, Steel and Allied Trades Federation, and for several years was responsible for the collection of statistics and their incorporation into an annual report. In 1918, at the instance of the Advisory Council for Scientific and Industrial Research, he prepared the first edition of a report on the sources and production of iron and other metalliferous ores used in the iron and steel industries of the United Kingdom.

To metallurgists in Great Britain and abroad Mr. Lloyd's knowledge, courtesy and kindliness were well known; to the staff of the Iron and Steel Institute he was a valued friend.

NEWS and VIEWS

Soil-less Cultivation

A review of the recent progress in soil-less cultivation has recently been given by Prof. R. H. Stoughton (*J. Min. Agric.*, 49, 25; 1942). In spite of many misconceptions and difficulties, steady progress has been made both in the laboratory and on small-scale semi-commercial installations, and a stage appears to have been reached when some reliable judgment can be formed on the question. Two types of systems are in use: (1) in which the plants are grown in a tank of nutrient solution with the roots immersed in a liquid medium; (2) where the permanent substratum is an inert material such as sand or gravel, to which nutrient solution is supplied at intervals. Carefully controlled trials have shown that in general the first of these is unsuitable for use in Great Britain, owing to the difficulty of securing adequate aeration for the roots, and the low light intensity. Far more promising results have been obtained with the second method, which may be considered under two main headings, namely, sand and sub-irrigation culture. In sand culture the plants are fed by watering on the nutrient solution from above, the surplus liquid draining away. Tomatoes, chrysanthemums, lettuce and a wide range of vegetables gave very satisfactory crops under these conditions, and promising results have been obtained with carnations using a slightly modified and simplified technique.

The disadvantages of the system, however, are the care needed in the control of the moisture content of the medium, and wastage of materials through drainage, but these are to some extent offset by the small cost of the outlay compared with the sub-irrigation method. In the latter case, the nutrient solution is pumped at intervals from below into the growing-tank until the gravel is flooded to the top, the pump is then shut off and the liquid flows back by gravity to the supply tank. The watering and feeding can thus be made almost automatic, the aeration of the medium is excellent and considerable economy in fertilizer materials is effected. Further, chemical sterilization of the gravel is easily carried out. To meet the criticism that soil-less cultivation results in crops of lower nutritional value, chemical analysis of the carbohydrate, protein, inorganic constituents and vitamin C content were carried out. No significant differences could be established between plants grown in gravel and those grown in soil. Experiments are now in progress at the University of Reading, under a grant from the British Electrical and Allied Industries Research Association, to test, among other things, the effect of heating the solution in the sub-irrigation culture of tomatoes. Work is also proceeding on the chemical testing of the solution by simple colour tests, so that its composition may be readily controlled according to the requirements of the crops.

American Newspaper Reporting of Science News

A review with this title by Hillier Krieghbaum has been published in the *Kansas State College Bulletin* (25, No. 5, Aug. 15, 1941; pp. 1–73); it is the sixteenth in a series of surveys of specialized branches of journalism. The beginnings of newspaper science reporting are traced: there was little interest among the early colonists, but as communities stabilized the outlook of editors grew. Benjamin Franklin could write with authority on science, but more usually items were reprints or grossly misinformed, and coverage was spasmodic. In the 1830's there occurred the rise of the penny Press and stunts and hoaxes became common; but editors were sceptical about the Atlantic cable, and Darwin's theory of evolution was barely mentioned. Again, in 1903, very few newspapers noted the first flight of the Wright Brothers. The section of the American Press led by Hearst and Pulitzer began, at the turn of the century, to search more widely for news sensations, but a fuller appreciation of science as news had to come through the War of 1914–18. E. W. Scripps was a pioneer in encouraging specialist writers for the Press, and it was his *New York Times* that was alone in publishing in 1919 an accurate story on the implications of the confirmation of Einstein's theory of relativity. In 1922 several writers attended the annual meeting of the American Association and one of them received a Pulitzer Prize for his work.

Scripps' interest in science led to the foundation and endowment of Science Service, formally known as the "American Society for the Dissemination of Science", launched in 1921 with the co-operation of three of the national scientific organizations. It was to be composed exclusively of men of science, with a layman journalist as editor; while not intended to be run at a profit, a fair charge for its services was to be made. Trustees were selected from the scientific bodies, the journalistic profession and the Scripps Estate. The first weekly issue of *Science News Bulletin* appeared in April 1921, edited by Dr. E. E. Slosson. To-day it is published for the general public as *Science News Letter*, and for the Press and radio there are syndicated news and features services; the director is Watson Davis, a member of the organization since its foundation. A technique was developed of writing stories for future release from advance information, and these are supplemented by regular articles by specialists. In 1941 the daily newspapers served in the United States reached eight million subscribers, with another million abroad before the present War. Science Service has aimed at being a liaison agency between the scientific world and the general public.

Scientific workers have felt in the past some antagonism—often justifiably—towards newspapermen: the independent scientific journalists of experience realized this and in 1934 formed in the United States the National Association of Science Writers, which now has twenty-eight members. The Association works with organizers of scientific conferences, and usually receives special facilities for advance information and 'off the record' talks. It is a mark of the success of the Association that in 1937 several of its members shared the Pulitzer Prize for reporting. To-day many of the large research laboratories and industrial organizations themselves issue material to the general Press. The 'science column' has become a permanent feature of many of the leading American newspapers, with additional activity in the fields of broadcasting and films, and a high standard of accuracy is maintained.

Early Astronomy in South America

In Leaflet No. 159 (May 1942) of the Astronomical Society of the Pacific, Roscoe F. Sanford gives a brief account of early astronomy in South America. Our knowledge of the subject results from a number of expeditions which were sent from the United States with the object of securing data on various astronomical matters. In 1847 Lieut. J. M. Gilliss, founder of the U.S. Naval Observatory, induced Congress to authorize and finance an expedition to South America to improve the value of the solar parallax. Cerro Santa Lucia in Chile was chosen as the site for the observatory, and great progress was made in the next three years, during which the positions of Mars and Venus were determined simultaneously in Chile and in the United States, mostly at Cambridge. Several years later, the reduction of these observations was carried out and a solar parallax of 8·5″ was derived. Research was conducted in other directions, and eventually the Chilean Government became so interested in the work that it arranged for young Chileans to be taught the use of the instruments. Later it purchased these and founded a National Observatory. Dr. Benjamin Gould, who had carried out the reductions for the solar parallax, interested Sarmiento, the Argentine ambassador to the United States, in a scheme for determining accurate star positions in a zone where observations were lacking, and the result was that the Argentine Government founded El Observatorio Nacional de Argentina in 1870, Gould being chosen as director.

Among other projects in South America, reference is made to another Argentine observatory, built at San Luis, through the influence of Prof. Lewis Boss, director of the Dudley Observatory in Albany, New York. This Observatory obtained a total of 85,000 star positions between 1909 and 1911. Before this, so early as 1890, Prof. S. I. Bailey established a station for the Harvard College Observatory in Arequipa, Peru; this was transferred to South Africa in 1926. In 1903 Prof. W. H. Wright established a station on Cerro San Christobal on the outskirts of Santiago for determining radial velocities. This station was known as the D. O. Mills Expedition of the Lick Observatory, and when the work was completed, the equipment was sold for a nominal price to the Catholic University of Chile. These and other astronomical ventures have established creditable cultural relations and lasting good-will between races with differences in customs, aspirations, and mode of thought, and have led to a better understanding of both scientific and political problems.

Origin of Meteorites

H. H. Mininger, Colorado Museum of Natural History, in a paper entitled "Trends in Meteoritics" (*Sky and Telescope*, 1, 8; June, 1942), gives a short résumé of our knowledge of meteorites. Most hypotheses in the past regarding the origin of these bodies gave more attention to iron than to stone meteorites, and erroneous conclusions were drawn. Chondrules, the most abundant of all meteoric constituents, have almost certainly been formed by repeated collisions between crystals and other solid bodies. For this reason, a situation which would provide for the rounding of crystals into chondrules would also produce the fragmentary matrix in which chondrules are usually embedded. It is suggested that in the past, when the sun was more active, extruded gases crystallized and collected into cometary swarms and within these swarms chondrules were produced by repeated collisions, while the aggregation of the resulting fragments and chondrules gave rise to meteorites. Some of the cometary swarms passed close enough to the sun to allow for the fusing of a percentage of the constituent grains, and this process was carried almost to the point of completely fusing the mass in the Lubbock aerolite, which was described in the *American Mineralogist* (25, 528–33; 1940).

It is surprising to learn that a considerable proportion of stony material which enters our atmosphere is reduced to dust. Dr. Lincoln La Paz has estimated that the Pasamonte meteorite weighed 66,000 tons at least when it entered the atmosphere, but only 4,000 gm. were collected. A huge dust cloud occupying about 1,000 cubic miles accounted for the principal mass of this meteorite. Further research on meteors may well yield useful information on the past history of the solar system.

The Beet Leafhopper

This insect, known scientifically as *Eutettix tenella*, forms the subject of Farmer's Bulletin No. 1886 (1941) of the U.S. Department of Agriculture, by W. C. Cook. We note in this publication a markedly enlarged dimension of its pages as compared with the usual run of its predecessors. Its value is thus enhanced by allowing of larger scale and more detailed illustrations and of a more convenient spacing of the letterpress. The beet leafhopper is native to the western United States and to northern Mexico, and is notorious as the carrier and transmitter of the virus of the destructive curly top disease of sugar beet and also of western yellow blight of tomatoes. During many years past the curly top disease has been a major factor limiting the production of sugar beet in many western areas. The whole problem of its control is a difficult one since direct spraying is rarely of value. In many areas the control of grazing is the most feasible method of attacking many of the plant hosts of this insect. In some cases reduction or elimination of the Russian-thistle, the most important summer host, by mechanical means is possible. The actual status of the natural enemies of the leafhopper is difficult to assess, but they are considered to be of great importance. The most notable are flies of the family Pipunculidæ and parasitic wasps of the Dryinidæ group. Predacious bugs, one of which is *Geocoris pallens*, are said to be of equal importance as parasites in reducing its numbers. The development and successful production of strains of beet resistant to the curly top disease has greatly reduced the losses incurred by the spread of the virus disease. By this means the cultivation of sugar beet has been made possible in districts formerly found to be unsuitable.

Earthquakes Registered in Switzerland

According to bulletins just received concerning earthquakes registered at the observatories of Zurich, Basle, Neuchâtel and Chur, fifteen earthquakes were consistently registered during February 1942 and nine strong earthquakes during March. Many of these have been mentioned previously in the columns of Nature, but epicentres on the European continent can now be given. On February 6 an earthquake recorded at Zurich at 00h. 10m. 46·6s. had its epicentre in the Rheintalgraben to the south of Freiburg. On February 7 an earthquake recorded at Zurich at 03h. 55m. 41·4s. had its epicentre near Venice. This was strongly recorded at all the stations. On February 12 an earthquake registered at Zurich at 16h. 03m. 17·5s. had its epicentre east of the Pelvoux-Massiv, in the Westalpen. This shock also was strongly recorded at all observatories. On February 17 an earthquake with its epicentre between Simmental and Kandertal in the Berneroberland was strongly recorded at all stations, the recording at Zurich being at 11h. 14m. 58·8s. On February 22 an earthquake recorded at Zurich at 22h. 34m. 38·8s. had its epicentre near the Stuttgart Rheintalgraben. The earthquake of February 28 (Zurich, 13h. 49m. 13·4s.) had its epicentre in the Bodenunruhe, and that of March 15 (Neuchâtel, 16h. 06m. 27·8s.) its epicentre to the south-east of the Neuenburgersee.

During April and May, 1942, thirty-one strong earthquakes were registered by the seismographs at the Swiss Observatories of Zurich, Basel, Neuchâtel and Chur, according to bulletins just received from Zurich. One epicentre, not mentioned previously in the columns of NATURE, is for the earthquake of April 12. The shock was recorded at Zurich at 00h. 02m. 53·9 U.T. and apparently came from an epicentre 420 km. distant. This epicentre is most likely to have been in the Udine Province of Italy.

Trachoma in the Argentine

ACCORDING to the April issue of the *Boletin de la Medicina Sanitaria Panamericana*, the provinces of Tucumán, Santiago del Estero, Santa Fé, Entre Rios, Corrientes, Salta, Jujuy and Misiones form the area most seriously affected by trachoma in the Argentine. The school is the centre for the control of the disease in children; specially trained doctors examine the children before school begins, and those found infective are given treatment in dispensaries and are not admitted to school until their eyes are normal. Meanwhile, the patients are visited by public health nurses, who instruct the family in treatment and prevention. Periodic visits to schools and dispensaries are made by medical inspectors of the National Department of Health, and teachers serve as intermediaries between the medical practitioner and the children. Intensive educational work is carried out by posters, leaflets and lectures, and preventive medicines are distributed. The result of this campaign during the last few years has been a reduction of the percentage of children infected with trachoma.

Yellow Fever in the Americas

IN a recent paper (*Bol. Of. San. Panamericana*, **21**, 320; 1942), Dr. Wilbur A. Sawyer, director of the Division of International Health, Rockefeller Foundation, New York, discusses the following features of the yellow fever situation in South America: (1) the absence of a definite outbreak of urban yellow fever transmitted by *A. œgypti*; (2) the absence of yellow fever of any type recognized outside South America; (3) the presence of jungle yellow fever, which takes the form of endemics, or epidemics spread over wide areas of South America. The chief features of control methods consist in weekly inspection of premises for *A. œgypti* larvæ, destruction of breeding-places and search for other mosquitoes by special squads. While cities may be kept free from infection by *A. œgypti* control, vaccination is the only measure practicable against jungle yellow fever; it can be carried out on a large scale and has been found both safe and effective.

Oil-bearing Plants in Sweden

ACCORDING to the June issue of the *Anglo-Swedish Review*, the cultivation of oil-bearing plants in Sweden has developed rapidly. In 1940 the area covered by such plants was only 938 acres, whereas in 1941 it was 21,250 acres, yielding a harvest of 10,000 tons of seed from which 2,700 tons of oil could be produced and 7,000 tons of fodder. This year it is established that the oil plant area is 42,500 or 45,000 acres, out of which 5,000 acres is rape, 32,500 acres white mustard, 1,000 acres poppy seed and 2,500 linseed. The yield will be at least 20,000 tons of seed, from which 6,000 tons of oil can be extracted, representing a little more than one tenth of the normal consumption of margarine in Sweden. It is considered likely that the cultivation of oil plants will be so extended that it will be possible to cover one fourth of the normal requirements of raw material for the manufacture of margarine.

University of London

THE following appointments have been made in the University of London: Dr. F. G. Young, since 1936 a member of the scientific staff of the Medical Research Council, to the University chair of biochemistry tenable at St. Thomas's Hospital Medical School; Mr. B. W. Windeyer, medical officer in charge of the Meyerstein Institute of Radiotherapy, Middlesex Hospital, to the University chair of radiology tenable at Middlesex Hospital Medical School; Dr. Alexander Lawson, lecturer in chemistry at University College, Southampton, to the University readership in organic chemistry tenable at the London (R.F.H.) School of Medicine for Women.

The title of reader in education in the University has been conferred on Mr. J. A. Lauwerys in respect of the post held by him at the Institute of Education.

Announcements

SIR GUY MARSHALL has resigned from the directorship of the Imperial Institute of Entomology. He is succeeded by Dr. S. A. Neave, who has been assistant director since 1913.

SIR LOUIS STERLING has been elected president of the British Institution of Radio Engineers in succession to Dr. C. C. Garrard. The presidential address, which is expected to deal with registration of engineers, will be read before the London Section of the Institution at a meeting to be held at the Federation of British Industries, 21 Tothill Street, Westminster, S.W.1, on September 25.

APPLICATIONS for the conditions of the competition for the Jones-Bateman Cup, offered triennially for original research in fruit culture which has added to our knowledge of cultivation, genetics, or other relative matters, may be had on application to the Secretary, Royal Horticultural Society, Vincent Square, Westminster, London, S.W.1.

ERRATA. "Relationships of some Primitive Tetrapods", by Dr. T. S. Westoll (NATURE, July 25, p. 121): paragraph 2, line 4, for "Burdie-house" read "Burdiehouse"; paragraph 4, line 3, should read ". . . strata of latest Dinantian (Viséan) and Namurian age. . . ."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

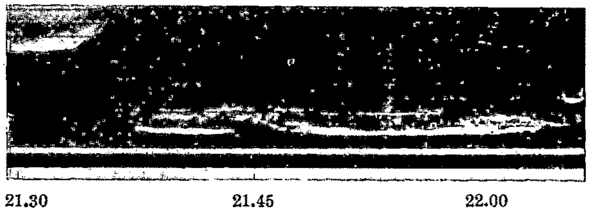
Holes in the Ionosphere and Magnetic Storms

There is good reason to attribute magnetic storms to neutral streams from the sun. These streams have equal numbers of positive and negative ions, because any excess would immediately be dissipated into the surrounding space.

The purpose of the present communication is to suggest, and put upon record, another effect of such streams which is supported by considerable evidence. When a neutral cloud enters the ionosphere, the electrons are brought to a standstill much sooner than the positive ions. Massey and Smith[1] have shown that, at cloud speeds of the order of 10^8 cm./per sec., the percentage energy loss in inelastic collisions for protons, a loss which would reduce their range, is negligible compared with that for electrons, and that the elastic collisions scarcely deviate the proton stream at all. The result is that, under proper conditions, the positive ions in the faster streams penetrate to the E layer, leaving the electrons in the higher regions. There is then a large electric force between the E and the F layers, and this electric force, together with the horizontal component of the earth's magnetic field, produces a violent drift of all the electrified particles in the F layer. The electrons which are in excess, and the positive ions, move from east to west and produce an effective west-to-east current in the upper layer. The opposite movement is produced in the E, or lower layer, but large mass movements are prevented because of the large molecular density there. If the neutral stream is local, the ionosphere is swept fairly clear of negative electrons and positive ions, and a big hole is produced. This may account for the very large reduction in the ionic content of the F layer during magnetic storms. Experiments have indicated that such large reductions do occur, and that these are sometimes much larger than the dilutions which would be produced by the heating of the upper atmosphere, a process which is entirely inadequate to account for the whole effect observed in certain cases. The accompanying illustration is from a photographic record of the 'hole' production during a magnetic storm.

The results obtained by Berkner, Wells and Seaton[2] on ionospheric effects associated with magnetic disturbances show that a hole is produced in the ionosphere at Huancayo at exactly the time that a magnetic storm starts (April 16, 1938). A little later in the progress of the storm, probably when the higher speed particles arrive, a sudden ionization is produced in the E layer. The whole sequence of the events observed at Huancayo can be completely explained in terms of this theory, and the statistical result that practically all magnetic storms are associated with a reduction in the F layer density is also explained.

This hole production is substantiated by a great deal of evidence. The electrons in the F layer and positive ions in the E layer move in such directions as to increase the horizontal magnetic field during a magnetic storm, and this corresponds with the normal first phase of such a storm. It has been suggested that no very marked effect will be produced because the electrons will spiral down the direction of the earth's magnetic field, and recombine at once with the positive ions, but it must be remembered that, as well as this spiral, there is a drift of the electrons from east to west in the upper layer, so that these may be removed far from the positive ions, which drift in the opposite direction before they can recombine. An appreciable increase of the magnetic field will obviously occur. What its amount is depends on the density of electrical particles in the stream. No exact numerical computation of this field increase can be made until this factor is known, but reasonable stream densities give reasonable increases of H. Thus, in a rough calculation, a stream with only 40 ions per c.c. will produce in a few seconds a field of 10 v./cm. with a drift velocity of 10 cm./sec. and an increase in H of the order of $100\ \gamma$.



Height of layer increases from bottom of record.

Although this theory, so far as it is associated with magnetic storms, needs a numerical backing, there can be no doubt about its effect in producing holes in the ionosphere. Much remains to be calculated, and the second phase of the storm may perhaps be associated with the drift of the electrons towards the positive ions, where they recombine. There is, no doubt, a magnetic storm effect as described in the ring production of Prof. S. Chapman. What is the relative importance of these two I do not know. But at least the mass movements of the electrons and their effective magnetic changes should be computed, and a critical analysis made to see if such mass movements can produce the effects observed in magnetic storms.

T. L. Eckersley.
Marconi's Wireless Telegraph Co. Ltd.,
July 16.

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[1] *Proc. Roy. Soc.*, A, **140**, 486, 142–272 (1933).

[2] *Ter. Mag. and Atmos. Elec.*, **44**, No. 3 (Sept., 1939).

Biotin, B_1, Riboflavin, Nicotinic Acid, B_6 and Pantothenic Acid as Growth Factors for Insects

We have already stated[1] that biotin is very likely a growth factor for the flour beetle *Tribolium confusum*. Growth of the larva is very much better on a diet consisting of casein, glucose, yeast, cholesterol, salts and water than when yeast is replaced by yeast extract (Table 1, 1). Normal growth is restored by adding the water-insoluble fraction of yeast[2]. All our previously reported experiments indicated that the missing factor in the yeast extract diet was biotin. Since then we have had the opportunity of testing first the most powerful concentrate of biotin then on the market ('Smaco'), and later pure biotin methyl ester ('Smaco'). It was found that both the concentrate (3) and the pure substance (4) improved very strikingly the efficiency of the diet which contained yeast extract instead of yeast.

TABLE 1. Basal diet: 50 parts casein, 50 parts glucose, 1 part cholesterol, 1 part McCollum's salt mixture and 15 parts yeast extract. Twenty larvæ in each test. Temperature 25° C. Relative humidity 70 per cent.

Additions to basal diet.	Period in days during which the first 10 pupæ were formed.
(1) none	39–48
(2) insoluble yeast	28–30
(3) biotin concentrate	28–31
(4) biotin methyl ester	
3·75 γ/gm. dry food	39–48
1·25 ,, ,, ,,	38–42
0·5 ,, ,, ,,	32–40
0·25 ,, ,, ,,	29–36
0·0625 ,, ,, ,,	30–36

The lowest two concentrations of biotin methyl ester used produced about the same effect, which is apparently the optimum. Larger quantities seem to be poisonous. It is, however, just possible that this poisonous effect was due to insufficient removal of the alcohol in which biotin methyl ester was dissolved. Since 0·25 and 0·0625 γ/gm. produced about the same effect, it is likely that the minimum quantities required for optimum effect might be lower still. As has been reported before for rats, yeast and other micro-organisms, the quantities of biotin required are exceedingly small, and many times smaller than those reported for other vitamins.

The availability of most of the members of the vitamin B group in pure substance made possible an attempt to grow Tribolium on a diet in which all the water-soluble B vitamins are supplied in pure form. By leaving out one vitamin at a time it was possible to establish which of the vitamins of the B group are essential growth factors for Tribolium (Table 2).

TABLE 2. Diet: 50 parts casein, 50 parts glucose, 1 part cholesterol, 5 parts insoluble yeast, 1 part wheat germ oil, 1 part McCollum's salt mixture and 15 parts water. Vitamin B_1, riboflavin, nicotinic acid, B_6, pantothenic acid, choline chloride, *p*-amino-benzoic acid (all used at the rate of 50 γ/gm. dry food). Twenty larvæ in each test. Temperature 25° C. Relative humidity 70 per cent.

	Period in days during which the first 10 pupæ were formed.
Whole diet	38–43
Diet without *p*-amino-benzoic acid	36–42
,, without choline chloride	38–43
,, without B_1	40–57
,, without pantothenic acid	50–61
,, without riboflavin	no pupæ; after 105 days most larvæ have died
,, without nicotinic acid	
,, without B_6	
Yeast extract instead of pure vitamins	28–30

From this series it appears that Tribolium does well without choline chloride and *p*-amino-benzoic acid. Without B_1 or pantothenic acid, growth is very considerably slowed down, and without riboflavin, nicotinic acid or B_6 growth comes almost to a standstill. This proves that at least these five vitamins of the B group are necessary growth factors, which is essentially in agreement with recent findings concerning the vitamin requirements of Drosophila[2] and mosquito[3] larvæ. But it does not prove that the two other substances are not necessary, or that the three substances without which no growth occurred are more essential than the two on which slow growth was possible. The diet contained the water-insoluble fraction of yeast, and we do not know what amounts of soluble factors this preparation might still have contained.

It will be noted that growth on the diet containing all the vitamins in a pure state is still considerably slower than when a yeast extract was supplied instead (Table 2). Similarly, a diet which contained the apparently optimum amount of biotin is still noticeably worse than one which contains insoluble yeast instead (Table 1). This indicates that, as was to be expected, there are still other growth factors contained both in the yeast extract and the insoluble yeast.

We wish to express our thanks to the Royal Society for a Government grant which made this investigation possible, to Dr. J. H. Sang for a gift of the biotin concentrate, to Mr. A. L. Bacharach (Glaxo Laboratories) for the gift of samples of vitamin B_6 and pantothenic acid, and to Roche Products, Ltd., for a gift of pantothenic acid.

G. FRAENKEL.
M. BLEWETT.

Imperial College of Science and Technology,
Biological Field Station,
Slough, Bucks.

July 2.

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[1] Fraenkel, G., and Blewett, M., NATURE, 149, 301 (1942).

[2] Tatum, E. L., *Proc. Nat. Acad. Sci.*, 25, 490 (1939); 27, 193 (1941).

[3] Trager, W., and Subbarow, Y., *Biol. Bul.*, 75, 75 (1938); Subbarow, Y., and Trager, W., *J. Gen. Physiol.*, 23, 561 (1940).

Steric Promotions and Inhibitions of Polarizations

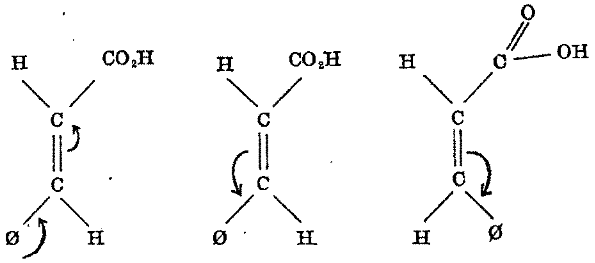
EXCEPTION is taken to the statement[1], "These new results appear to confirm the suggestion made in the Annual Reports for 1939 that the various manifestations of the 'ortho-effect' cannot be interpreted on the basis of a single conception". The *new* results are in complete accord with the ideas expressed in my earlier communication[2]. This letter pointed out that polarizations can be *promoted* as well as inhibited by steric congestion, and the data of R. D. Kleine, F. H. Westheimer and G. W. Wheland[3] offer an excellent example of both.

The dissociation constant of acrylic acid is not much greater than that of trans-cinnamic acid[4], and polarization represented by formula I can be only slightly more developed than that represented by II.

Collision between nucleus and carboxyl group in cis-cinnamic acid produces a torque in the ethylenic linkage which decreases the degree of double bonding; however, this collision occurs at the oxygen atoms and in a direction (perpendicular to the plane of the C-C-O atoms) producing, together with a torque in the ethylenic linkage, an orientation of the carboxyl group (as shown in III) unfavourable to the polarization which develops greater electron density in the neighbourhood of the carboxyl group. In consequence, the polarization shown in III is preferentially developed and the dissociation constant is greater than that of the trans-isomeride. This polarization is augmented by the methyl group in cis-α-methylcinnamic acid and the dissociation constant is correspondingly increased.

The torque in the ethylenic linkage of trans-α-methylcinnamic acid is produced by the collision of the methyl group with the nucleus, and the weakening of the double bond can be utilized by a suitably oriented carboxyl group (as illustrated by IV) to produce a low dissociation constant. Again, the methyl groups of cis-2 : 4 : 6-trimethylcinnamic acid do *not* orient the carboxyl group out of the plane which includes the carbon atoms embracing the ethylenic linkage; consequently, the dissociation constant of this acid is lower than that of the trans-isomeride.

Although the benzene ring has a high reactivity in both *N*-methylindoline and *N*-methyltetrahydroquinoline, only derivatives of the latter can exhibit inhibited mesomerism. For example, one can safely predict that the introduction of a methyl group into the 8-position of the latter will have a depressing effect on the behaviour of the benzene ring towards electrophilic reagents, an effect which will not be realized by the introduction of a methyl group into the corresponding position of the former. Work in these laboratories has shown that whereas 5 : 8-dimethyl-α-tetralone isomerizes to the 5 : 7-isomeride in the presence of aluminium chloride and hydrolyses to γ-(2 : 5-dimethylphenyl) butyric acid with phosphoric acid, 4 : 7-dimethyl-α-hydrindone cannot react in either of these ways. These differences reveal that, in the α-tetralone homologue, ring puckering can allow steric conditions to inhibit the mesomeric effect of the carbonyl group and promote a nuclear polarization represented by V in which the carbonyl carbon atom is deflected out of the plane of the benzene ring.



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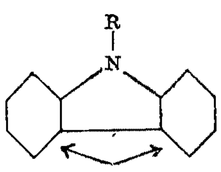
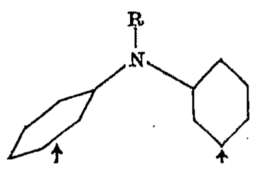
Finally, there should be little difficulty in interpreting the lower reactivity (towards deuteration) of carbazole derivatives relative to the corresponding diphenylamine derivatives; only in the latter, as illustrated, can suitable orientation allow of a high reactivity.





The closing of one channel so as to obtain the maximum effect down a second channel was exemplified in my earlier communication[2] by "the abnormally slow alkaline hydrolysis of *o*-relative to *m*- and *p*-acettoluides".

I would like to take this opportunity to express my indebtedness to Prof. J. Kenner for the interest he has taken in the development of these ideas and the encouragement he has always offered me.

G. Baddeley.

College of Technology,
Manchester.

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[1] Watson, *Annual Rep. Chem. Soc.*, **38**, 127 (1941).

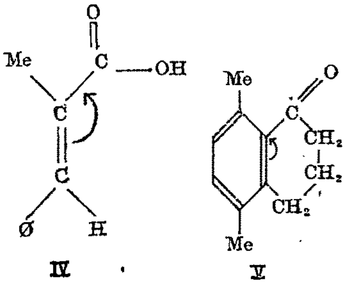
[2] Baddeley, Nature, **144**, 444 (1939).

[3] *J. Amer. Chem. Soc.*, **63**, 791 (1941).

[4] Ostwald, *Z. phys. Chem.*, **3**, 273, 276.

Science, Politics and Service

The contribution of science to the planning of society and particularly to the shaping of its own opportunities seems to be in considerable part confused by a division of many men of science into two contending elements which are essentially parallel with political factions, though perhaps not always conscious of these allegiances.



IV V

A key point at issue is the advisability or inadvisability of State control, that is, whether the works of science are to be centrally organized or left solely to individual initiative, and the gulf between these two views is widened by the opposition of the political impulses of many of their respective adherents. A solution of this *impasse* is obtained by clearly recognizing the need both for organized and for individual development. No one will deny that research in biological and social subjects, and perhaps in others, requires expansion by governmental action and also co-ordinating direction towards the most immediate problems; while the present level of independently undertaken research could be preserved, the work of the limbs of the State-aided scheme could be directed by committees composed of representatives elected by the Government, by scientific societies and by the various research departments, academic and other. Full scope would then be accorded to creative originality, while the nation would also profit from direct contributions by all available experts to its urgent problems; the result would be implementation of common desires, and not loss of freedom. A prime aim of science being to educate and advise, but not to administer, outside its own sphere of working, co-operation with Governments in schemes of research and development would give place for a helpful influence on statesmen.

While many differences in opinion among men of science are a sign of vigour and independence, none the less serious rifts in policy through allegiances to non-scientific causes are likely to be harmful. The growing need for scientists to educate and inform the general public and politicians could not be fulfilled if substantial support had been shown to any one particular faction as a display of personal inclinations, or less personally, to court favours from the apparently more promising source. Politicians are more fickle and self-centred than men of our tradition, it is to be feared and hoped; and also with parties losing or retaining power unpredictably, the financial axe would ever threaten to be used as an excuse to cut down or withhold the schemes urged by the supporters of former Governments or other parties. Expression in active politics seems suitable for the man of science only in his single and private capacity as a citizen; it is not a function of or a benefit to the way of science, and it would enrage just as much as engage attention. The use of the cause of science to give support to the cause of some political party is quite imaginable, though any such confusion, or linkage of causes would be wholly reprehensible.

Men of science, politicians and the various groups of the public largely limit the application of their minds to channels so distinct that their view-points lack sympathetic knowledge each of the others. Unity and power of presentation of policies are therefore essential. Science has often excessively suffered by lack of appreciation of its purposes or by the occasionally misguided zeal of its devotees, and evidence for this misunderstanding need be sought no further than in the sphere of religion.

The duty of men of science is clearly to avoid incrimination of science in party politics but to seek a commonly agreed belief and policy, so far as is humanly possible, for science in general and the sciences in particular, which they would severally labour to enlarge and which they would suitably impress on the non-scientific world with greater force and penetration than are at present employed.

While planning for international collaboration and admiration for the achievements of certain other countries are eminently commendable, the existence of strong elements in Britain, America and elsewhere neither similarly inspired nor likely to be converted by reasoned disquisitions should induce a practical note of not untimely caution. These other countries enjoy great national prides and ambitions, each in its own way; and the British Commonwealth of Nations, realizing that they themselves must play an undeviatingly strenuous part in pressing world peace, will prove their virility and capability for such leadership by assuring their own prosperity, power and honour. Through incomplete understanding of our history, the rallying call of 'Britain and Empire' has become one almost for abuse, though, national prides and sectional urges being what they are and will for long remain, it is essential as a preventive against factious disintegration and as a prerequisite of a still wider well-being. Men of science in the British Commonwealth of Nations should play no small part in fostering all that redounds to the prosperity and glory of Britain and Empire, so helping to draw together the impulses of a great variety of people with advantage for understanding and action in other directions, not the least being appreciation of the full material and social benefits obtainable from science.

Recognition of the beneficial power of our national pride is not shallow nationalism but a reasoned feature of politico-sociology resulting from the observation, as any competent journalist knows, that the great majority of people are reached only through their emotions. Indeed, men of intellectual attainments are in little better straits and their views are very diverse and often antagonistic, so that no reason exists for not seeking and integrating common national traits to serve as a springboard for further progress. Too frequently an active common spirit in the country is promised, somewhat optimistically or alluringly (or even threateningly, as a *sine qua non*), to result only from extensive schemes of reorganization; this spirit of service and fellowship should be engendered now, not only to assist the war effort but also for peace and to prepare for those changes of organization that the country may choose in the course of time. Propaganda—a word denuded of evil if the weight of science and culture were behind it—would here prove of great value for both the present and the future.

It is a tragedy for Great Britain that the valuable qualities of scepticism and individualism among its inhabitants tend to deprive them of the intense love of country and the virility so much needed for strength and progress in these decades when this essentially commercial country is facing both wars and growing competition in the world of industry.

JOHN PETRIE.

Universities in War-time

SURELY the article on "Universities in War-time" in NATURE of July 25, p. 97, omits to mention the most powerful of all motives which impel men to thought and to action at such a time as this and whether they are in a university or in the Fighting Forces; nowhere is 'love of country' or patriotism mentioned. Our lost capacity for moral indignation is lamented; I would rather rejoice over the fact that our sense of patriotism is bright and burning as of old. To mark the fate which meantime has overwhelmed France seems to me to supply an infinitely more powerful incentive to endeavour than the fear of a twilight falling on our "moral standards and spiritual values".

There is another omission of even greater import. Nowhere is it made clear to readers that when a nation passes from a state of peace to one of war, it has to scrap not only its peace-time economics but also, so far as the enemy is concerned, its peace-time code of "moral standards and spiritual values"; to refuse to do so would ensure its speedy defeat. Germany passed from a peace to a war footing in 1933; we are now at the stage which Germany reached about 1936. German universities were bound to the war chariot at an early stage; ours are still free. Long may they be so!

Civilization is defined as "self-discipline", its advance measured "by man's gradual mastery of his more savage instincts". Whether we like it or not, in war we must confront the enemy with the heart of a savage and with a head fortified by all the cunning which civilization can give it. Germans had to give up their individual liberties in 1933; ours have to go now. Will we—or for that matter our enemies—get them back when peace comes? That depends upon what use Germany makes of peace rather than upon our wishes.

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An Undescribed Stage of Sarcotaces

THE systematic position of the genus Sarcotaces, according to Calman[1], is quite obscure, for as a result of the extreme degeneration shown by the parasite most of the characteristic features have disappeared. Although *S. arcticus* is not infrequent in the blue ling, *Molva abyssorum*, appearing as dark oval-shaped cysts lying among the myotomes of the lateral line, it has only been very briefly referred to by Collett[2] and Hjort[3], who suggested that it was a Cirripede. Two other species have been recorded, *S. verrucosus* by Olsson (1873)[5] from Acanthurus in the West Indies, and *S. pacificus* from Antennarius at Misaki, Japan, by Komai[4], who suggested that it belonged to the Copepoda.

In all three species the only stages described are the adult female, which occurs in the ovoid cysts of the lateral line and in the case of *S. arcticus* reaches the dimensions of 55 mm. in length by 25 mm. in diameter, and the nauplius, which can usually be found in the space between the female and the cyst wall.

Through the kindness of Dr. R. S. Clark and Prof. Edward Hindle, I have had the opportunity of re-examining cysts of *Sarcotaces arcticus* found in blue ling landed at Aberdeen, and found what seems to be the male form of this parasite.

A total of twenty-six cysts was examined, all of which contained ova and nauplii in addition to the adult female, and in nineteen of them a hitherto undescribed stage was found, shown in Figs. 1 and 2. The numbers present in each cyst varied from one to four; they were always found attached to the cyst wall by their ventral surfaces. Their dimensions never exceeded 3 mm. in length, exclusive of the caudal furca, 0·6 mm, in breadth, and 0·2 mm. in thickness. The anterior part is expanded to form a triangle, ending in a small head (Fig. 2). Slight constrictions seem to indicate segmentation, and there are a number of pairs of vestigial appendages. The head bears four pairs of appendages, antennules, antennæ, mandibles and postoral appendages which may be small maxillules or maxillæ.

The ventral surface of the expanded triangular part of the trunk bears two pairs of biramous appendages, and along the length of the body are one or two pairs of hook-like appendages. The telson bears a caudal furca, which is very variable in size.

The mouth leads directly into the alimentary sac, which like that of the female ends blindly and contains a dense black substance probably derived from the blood pigments of the host. Behind the gut are two masses of densely staining tissue suggesting testes, but the material was not sufficiently well preserved to identify the nature of the cells. Although there was a suggestion of a genital duct leading from these organs, no external aperture could be detected.

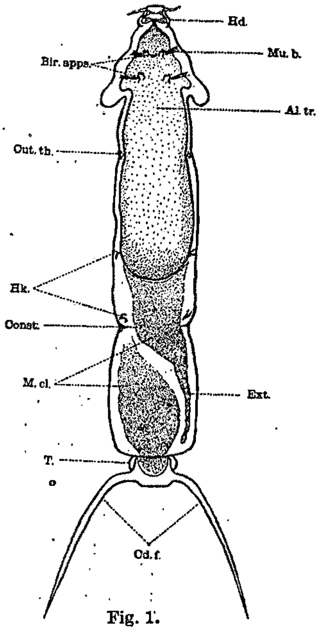

Fig. 1.

Ventral aspect of small parasite from cyst of *S. arcticus*.

Al. tr., alimentary tract; Bir. apps., biramous appendages; Cd. f., caudal furca; Cut. th., cuticular thickenings; Const., constriction of trunk; Hd., "head"; Hk., hooks; M. cl., cell masses (testes?); Mu. b., muscle band; T. telson; Ext., posterior extension of cell mass.

There can be no reasonable doubt that these parasites represent a stage in the life-cycle of Sarcotaces. It is very unlikely that they are the progeny of the large individual, and on the evidence are most likely to be males. Komai claimed to have identified testes as well as ova in large individuals of *S. pacificus*, but this statement is open to question in view of the absence of hermaphroditism in all known Copepods.

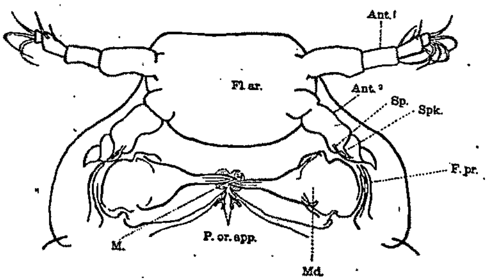

Fig. 2.

Ventral aspect of head.

Ant.^{1}, antennule; Ant.^{2}, antenna; Fl. ar., frontal area; F. pr., falciform process; M., mouth-opening; Md., mandible; P. or. app., postoral appendages; Spk., spike-like process; Sp., spine.

The stage of *S. arcticus* described above suggests that this species belongs to the Copepoda and, in view of its form would seem to be most closely related to the family Philichthyidæ.

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July 17.

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[1] Calman, W. T., "A Treatise on Zoology", Part 7, *Appendiculata* (A. and C. Black, London, 1909).

[2] Collett, *Forh. ved de skand.*, 11 Møde i Kjøbenhavn (1874).

[3] Hjort, J., *Skr. Vidensk. Selsk., Christ.*, 1 Math. nat. Kl., No. 2 (1895).

[4] Komai, T., *Mem. Coll. Sci. Kyoto.*, B, 1, No. 3 (1924).

[5] Olsson, quoted by Hjort, *loc. cit.*

Preservation of Historic Machines and Apparatus

Care to ensure that nothing of permanent documentary value should be allowed to go to salvage during the present drive has been publicly emphasized by the Right Hon. Lord Greene, Master of the Rolls, as president of the British Record Association, as well as by other authorities.

The Council of the Newcomen Society directs attention to the corresponding need for watchfulness in the preservation by firms, public bodies and individuals, not only of documents but also of objects of enduring engineering and scientific interest. The Council had before it the case of the irreparable loss to Manchester of Richard Roberts's slide lathe of 1820 which was scrapped because "The lathe was very large and not complete [this was incorrect] and was seriously obstructing our work". A more recent attempt to scrap the contents of Wortley Iron Works near Sheffield, particularly two unique eighteenth-century tilt hammers, has fortunately been averted by prompt action. Such danger of destruction is greatest when the salvagers are enthusiastic but ill-informed persons.

The Council appeals for sufficient delay to get advice when in any doubt; there are several quarters that can give it, which the Society will be pleased to indicate if called upon.

E. Lancaster Burne
(President).
H. W. Dickinson
(Hon. Sec).

Newcomen Society,
123 Riddlesdown Road,
Purley, Surrey.

RESEARCH ITEMS

Fraternal Twins

J. W. MacArthur has made an analysis of the factors related to the production of fraternal twins (*J. Hered.*, 33, 87; 1942). He points out that body size of the animals is correlated with the number in the litter. For example, seven generations of mice selected for body size in a plus direction weighed 27 gm. and produced 9–10 in a litter, whereas selected in a minus direction they weighed 14 gm. and produced 5–6 in a litter. Similar evidence is recorded from other animals. Twins are more prevalent among Nordic people than in the Mediterranean region, and the author points out that stature is greater in the more northern parts of Europe. Similarly, Negroes in the United States have a twin rate of 1 in 69 births, whereas the Japanese have the lowest known figure of 1 in 301. Twinning is believed to be inherited through both male and female lines, and to be largely dependent on those genes which influence body size.

Coiling of Chromosomes

Trillium species provide valuable material for observations on chromosome coiling, which is considered by many cytologists to be of fundamental importance. G. B. Wilson and I. Hutcheson (*Canad. J. Res.*, **19**, 383; 1941) show that in *Trillium erectum* reversals in the direction of coiling across the attachment region are at random; across a chiasma there is a frequency of 1 : 6 : 1 of 0, 2 and 4 reversals in direction of coiling of the four chromatids. It is shown that there is an average of two reversals per chiasma. Reversals of direction take place without chiasma formation; once in approximately 17 gyres. There is thus, the authors contend, no grounds for a torsion theory of spiralization and no signs of an inherent ground pattern of structure that determines directions of coiling. A. H. Sparrow, C. L. Huskins and G. B. Wilson (*Canad. J. Res.*, **19**, 323; 1941) have studied the length changes of the meiotic and mitotic chromonemata in *T. erectum* and *T. grandiflorum*. Elongation occurs between early diakinensis and anaphase I and between anaphase II and prophase of the microspore division. Contraction occurs between zygotene and diakinesis, between anaphases I and II and during microspore and prophase. The authors discuss prevailing theories and put forward the view that the coiling is brought about by elongation of the chromomena within a space confined by the pellicle. It is probable that spirals of sister chromatids are always in the form of orthospirals (plectomenic), that is, they are interlocked at each twist. The authors show the importance of this evidence in considering the mechanism of chromosome behaviour.

Pacific Foraminifera

J. A. Cushman now publishes the third part of his work on the Foraminifera of the tropical Pacific collections of the *Albatross*, 1899–1900 (United States National Museum, Bulletin 161; 1942). This deals with the families Heterohelicidæ and Buliminidæ. Certain other related material from shallow water of the same region is also included. Some interesting relationships have been noted in these faunas, in which are living representatives of species known hitherto only from the late Tertiary of other regions. The number of distinctive species in this area is very large. Many were originally described by H. B. Brady from the *Challenger* material. *Bolivinita quadrilatera* is a species occurring in the *Albatross* stations sometimes relatively abundantly, and also in 3–12 fathoms off Fiji. It apparently also occurs in the Atlantic, but it is an interesting fact that the Atlantic specimens as a rule seem to lack the basal spine. The fauna of the Miocene of France is related in many ways to the present Indo-Pacific fauna. It is therefore not surprising that a typical specimen of *Bolivinella margaritacea* described from the Miocene of France should have been found in the material from Rutavu.

Biology of Beetles of the Family Dermestidæ

Memoir 240 (Dec. 1941) of the Cornell University Agricultural Experiment Station is entitled "Studies on the Biology of Four Common Carpet Beetles". Part 1, dealing with three of the species in question, is by Grace H. Griswold, and Part 2, which is concerned with *Anthrenus scrophulariæ* only, is by Margaret Greenwald. It appears that very little detailed work has been done on these important pests. The black carpet beetle (*Attagenus piceus*), the varied carpet beetle (*Anthrenus verbasci*) and the furniture carpet beetle (*Anthrenus vorax*) are widely distributed throughout the world. The larvæ feed upon materials of animal origin and cause much damage to rugs, carpets, upholstered furniture, also woollens, furs, etc. The first two species also feed on cereal products and at times cause trouble in flour mills and granaries. In breeding these insects, woollen cloth of some kind has always been kept in each jar or receptacle and fish meal has proved satisfactory as a food for the larvæ. In all three species several months are spent as larvæ. For *A. piceus* the period was never less than 8 months and some individuals lived as long as 21 months. In the case of *A. verbasci* the larval life was slightly shorter but never less than 7 months, while in the case of *A. vorax* the period ranged from slightly less than 4 months to more than a year. The adult life in the first two species ranged from 13 to 44 days, whereas *A. vorax* lives as an adult from 44 to 251 days, the females living rather longer than the males. The fourth species, *Anthrenus scrophulariæ*, may pass its entire developmental period (egg to adult) in 78 days, but may be prolonged to at least 439 days. The beetle itself feeds upon pollen of various flowering plants—at least twenty-seven species of these being known to be resorted to. The paper includes a list of more than a hundred references to works on the insects in question.

Selachine as a Colour Neurohumour in Sharks

G. H. Parker read a paper on this subject at the annual general meeting of the American Philosophical Society during April 23–25. In the common bull-head, the darkening of the fish is due to intermedine from the pituitary and acetylcholine from dispersing nerve terminals near the colour cells, and the blanching to adrenalin from concentrating nerve terminals also near the colour cells. In the smooth dogfish *Mustelus canis* darkening is due to the pituitary neurohumour intermedine. The occasion of its blanching is less clear. This colour phase has been variously claimed as due to the mere absence of intermedine, to a pituitary blanching agent, the *W*-substance, or to a concentrating nervous neurohumour. No evidence in favour of a *W*-substance has been found in Mustelus, but this fish does blanch on loss of intermedine. When its integumentary nerves are cut the denervated areas become pale. Such blanching is not due to a disturbance in the blood supply, for it occurs when the blood vessels of the region are not interfered with. Such pale areas can be revived by recutting their severed nerves. From such skin a neurohumour can be extracted with ether or oil that will blanch a dark fish locally on injection. This neurohumour is in effect like adrenalin, but it is not adrenalin for it is not soluble in water and it is not destroyed by heat. It is peculiar to the shark; hence it has been called selachine. It causes blanching in Mustelus when the fish is low in its intermedine.

Water Reserves in Brazilian Forest Soils

THIS feature of some of the soil in the vast forest areas of Brazil is emphasized by Felix Rawitscher in his transpiration studies by rapid weighing methods under field conditions (*Anais da Academia Brasileira de Ciencias*, 14 (1), 1942). The soil depth in tropical and sub-tropical regions may reach a maximum of 15–20 metres, and considerable water reserves may be accumulated in the deeper layers of soil. During the dry period of the year these furnish water, not only to sources and streams, but also to the deeper plant roots. Large zones of humid forests in the interior of San Paulo live on these reserves during the dry period. The author suggests that the high transpiration rate of extensive humid forests must have a considerable influence on the humidity of the climate.

Amber Spiders

A. PETRUNKEVITCH's well-known monograph on Carboniferous Arachnida is now supplemented by a lengthy study of spiders preserved in Baltic amber (*Trans. Connect. Acad. Arts. Sci.*, 34, 119; 1942). The 140 specimens named represent 78 species, 69 of which are new, included in 27 families, 5 new. The descriptions are as detailed as the state of preservation allows, aided by a special technique, a full account of which is given. The work is illustrated by more than 500 line figures and 100 photographs. Prof. Petrunkevitch also summarizes the changes that evolution seems to have wrought in the structure of spiders, especially in the circulatory and respiratory systems, leading first to the conclusion that the habits of spiders must have become differentiated before the Oligocene, and secondly to much discussion as to the most acceptable way in which these evolutionary trends may be represented in the classification of the order. The monograph is both informative and provocative to a degree.

High-Pressure Measurements

Two further instalments of P. W. Bridgman's researches on the physical properties of substances at high pressures have been published (*Proc. Amer. Acad. Arts and Sci.*, 74, 399 and 425; 1942). The first deals with freezing parameters and compressions of twenty-one substances, chiefly organic liquids, up to 50,000 kgm./cm.^{2}. The general conclusion from this new work in a pressure range three or four times the previous range is that the melting curves give no evidence for critical point, maximum temperature or temperature asymptote. The curves continue to rise to indefinitely high pressures and temperatures, with continually decreasing slope $d\tau/dp$ and continually decreasing volume discontinuity between solid and liquid. The second paper deals with pressure-volume relations for seventeen elements to pressures of 100,000 kgm./cm.^{2}. In general the compressibility falls off less with rising pressure than might have been expected. Full details are also given of the experimental technique needed to overcome the special difficulties of working at these higher pressures.

The True Galactic Pole

O. R. WALKEY has prepared an account of the various positions found for the galactic pole from the days of Sir William Herschel down to modern times (*Observatory*, No. 808, 64; June 1942). Of the twenty positions determined, seven were derived by the galactic belt, four from star counts, and nine from galactic objects. These are tabulated and are all reduced to the epoch 1900 position. The true position of the galactic north pole, using all the results, is at R.A. 12h. 48m., Dec. + 27°, in Coma Berenices (epoch 1900), and it is remarkable that this coincides exactly with Newcomb's combined position tabulated for the galactic belt. It seems highly probable that the epoch 1950 co-ordinates will be in use after the next meeting of the International Astronomical Union, in which case it will be sufficiently accurate to adopt the 1950 R.A. as 12h. 50m. and Dec. as + 27°.

Solar Eruption and Magnetic Storm of March 1-2, 1942

A PROBABLE connexion between the intense solar eruption of February 28d. 12h. and the magnetic storm which followed has been demonstrated by H. W. Newton (*Observatory*, No. 808, 64, June). M. A. Ellison at Sherborne observed the eruption first on Feb. 28d. 12h. 42m. U.T. in $H\alpha$, and from the presence of descending dark flocculi near the bright emission he inferred that the eruption had been in progress for some time. Observations were also made by P. Laurie with the Greenwich spectrohelioscope, but a cloudy sky prevented observations in the earliest stage of the eruption. While the average duration of a brilliant eruption is about ¾ hour, the eruption of Feb. 28 lasted for more than 3½ hours—an exceptional time; but it is suggested that it may have consisted of multiple eruptions with the greatest integrated intensity between 12h. 0m. and 12h. 47m., and strong evidence for this view is given in the paper. On Feb. 28d. 12h. 0m. there was a sudden fade-out (ionospheric irruption of the Dellinger type) and this continued on some circuits until 20h. This was an abnormal duration for a fade-out of this type. A great magnetic storm commenced 19½ hours after the beginning of this sudden fade-out and the following figures from the Abinger magnetic traces show the intensity of the storm:

D	9° 48·7′ at	1d.	9h.	30m. to	11° 14·8′ at	1d.	7h.	51m.
H	0·18194	1	8	50	0·18706	1	9	59
V	0·43048	2	1	45	0·43224	1	9	59

These are the extreme ranges in each case.

Assuming that the ejection of the stream of corpuscles occurs about the time of peak intensity of the bright eruption, which is also closely indicated by the beginning of the radio fade-out, the time required by the stream to reach the earth was 19·4 hours. The data for Sept. 17–18, 1941, gave 20·5 hours and those for Feb. 28–March 1, 1941, gave 18·5 hours. Statistical evidence suggests that in the case of intense magnetic storms in areas where spectroscopic observations have located a brilliant solar eruption within the preceding 1½ days, the effective time of travel is shorter than the mean.

OPEN-HEARTH FURNACE REFRACTORIES

THE first part of the joint meeting of the Iron and Steel Institute and the Society of Engineers and Metallurgists, held at Sheffield on May 19, was devoted to basic refractories, with particular reference to stabilized and semi-stabilized dolomite; and the second part was confined to a co-operative study of a silica roof trial on a basic open-hearth furnace. The discussion was based on reports and papers already published, to which reference is made in the appropriate footnotes.

Dolomite Refractories

The work described by Dr. J. R. Rait[1] has shown that when dolomite is stabilized, by the use of siliceous materials added before calcination, the principal mineral phases are tricalcium silicate ($3CaO.SiO_2$), periclase (MgO), brownmillerite ($4CaO.Fe_2O_3.Al_2O_3$) and dicalcium silicate ($2CaO.SiO_2$). Insufficient siliceous stabilizer leave some free lime which becomes hydrated and causes disintegration of the clinker, while excess results in the formation of dicalcium silicate ($2CaO.SiO_2$), which may cause 'dusting' at its β–γ inversion temperature (675° C.). If the iron oxide content of the mixture is more than that required to form brownmillerite with the available alumina, dicalcium ferrite ($2CaO.Fe_2O_3$) is also formed, whereas with excess alumina, tricalcium aluminate ($3CaO.Fe_2O_3$) appears.

The stabilization of dolomite by silicate minerals is dependent on the firing temperature as well as the proportions of the reactants. Owing to the limited stability range of $3CaO.SiO_2$ (1,300°–1,900° C.) care is necessary to avoid the formation of dicalcium silicate and free lime in a chemically balanced mixture. This breakdown of tricalcium silicate ($3CaO.SiO_2 \rightarrow 2CaO.SiO_2 + CaO$) may occur in the kiln firing of the clinker or in the firing of the bricks made from the clinker under certain conditions. Small quantities of some materials, for example, $Cr_2O_3.P_2O_5$, suppress the β–γ inversion of dicalcium silicate.

Study of the mineral constituents of stabilized dolomite was effected by X-ray diffraction apparatus, and examination of a number of materials showed that serpentine (used commercially), chromite and chromic oxide all produce clinkers highly resistant to hydration. Zirconia also gave promising results.

The relatively low resistance of fully stabilized dolomite to cracking when subjected to thermal shock is attributed to the physical condition of the material. Cracks, once started, are not stopped or deflected at grain boundaries but are propagated through the grains themselves. Better thermal shock resistance is usually shown by the semi-stabilized dolomite products, which have special spheres of usefulness.

A note by Dr. W. J. Rees[2] indicated that a semi-stable product containing 95 per cent dolomite, 2·5 per cent ball clay and 2·5 per cent mill scale might be used as a crushed aggregate and could be produced in a rotary kiln. The product has a high resistance to corrosion by basic-open-hearth slag and a fair resistance to thermal shock; also its resistance to hydration is such that it can be kept for some weeks without deterioration. It is possible to produce a partially stabilized brick by controlled firing in one operation, but the two-stage method (clinker → brick) is considered preferable as it gives a better shaped brick.

The production of dolomite bricks for use in steelworks was described[3], special attention being given to the replacement of magnesite refractories by stable or semi-stable dolomite bricks.

It has been shown that high-temperature calcination (or even electrical fusion) of dolomite does not yield a stable product. The magnesia and lime formed by the reaction: $CaCO_3.MgCO_3 \rightleftharpoons MgO + CaO + 2CO_2$ are both of moderate crystal size (about 0·5 mm. diameter) but the lime, unlike the magnesia, is readily hydrated after only a few days exposure to the atmosphere. The use of the term 'dead-burned' in connexion with high-fired dolomite is thus a misnomer.

During the last twenty years numerous attempts to stabilize dolomite have been made. Probably the first really successful works-scale experiments were those made in Great Britain in 1934 by Dr. W. H. Tyler and W. J. Rees[4], using a mixture of dolomite and sudanite rock (magnesite + talc). Nowadays, serpentine is used instead of sudanite rock, but the composition of all the fully stable dolomite bricks now in use in Great Britain is essentially the same as that employed in 1934, when dolomite brick technology was greatly advanced.

Apart from serious brick-to-brick variations in the early stages, two serious limitations arise periodically, namely, hydration in storage and 'dusting' in the furnace. X-ray examination showed the former to be due to insufficient silica content or inadequate firing (leaving uncombined lime), and the latter to the formation of dicalcium silicate. It is preferred in manufacture to keep the composition slightly on the silica-rich side of tricalcium silicate and add certain of the known stabilizers (for example, phosphorus pentoxide) to prevent the inversion of the small amount of dicalcium silicate so formed. The high-temperature breakdown of tricalcium silicate can lead to trouble in firing or in subsequent storage of the bricks.

The properties of stabilized dolomite bricks are characterized by porosity and permeability of the same order (20–25 per cent and 0·1 c.g.s. units) as those of magnesite bricks, good volume stability at 1,500° C. and high cold-crushing strength. Their refractoriness-under-load is high, but their thermal shock resistance is rarely greater than two reversals as compared with five to eight reversals for ordinary magnesite bricks. They do not disintegrate on boiling in water for 24 hours and show no free lime by the glycerol or White's test, while their thermal conductivity is little more than half that of magnesite. The analysis, which is determined largely by the silica requirements of the lime to form $3CaO.SiO_2$, shows about 15 per cent of silica and equal proportions of lime and magnesia.

Bricks of the semi-stable type were the first to give successful steelworks furnace service. Although containing free lime, the safe-storage time is sufficient for normal purposes, and better thermal shock resistance is obtained than with the fully stable brick. The storage time can be increased by impregnating the fired brick with organic stabilizers. Semi-stable bricks are usually made by mixing calcined dolomite ('basic') with suitable fluxes, moulding with the addition of a temporary bond such as tar and firing in the normal way.

The porosity is of the same order as that of stabilized bricks but the permeability may be higher.

While the crushing strength is usually adequate, it is often about half that of stabilized brick; but the refractoriness-under-load is fairly high. The thermal shock resistance is definitely superior (twenty reversals or more) and the resistance to slags high in iron oxide and lime is also greater. Chemically, this type of brick differs little from the ordinary 'basic' used for fettling open-hearth furnaces. Silica is slightly higher and the lime content normally exceeds the magnesia content to an extent determined mainly by the composition of the dolomite used.

Promising results, particularly as regards improved thermal shock resistance, have been obtained with mixtures of dolomite and magnesite, but such bricks are not yet manufactured commercially.

Basic Open-Hearth Furnace Roofs

Three factors have contributed largely to improved durability of basic open-hearth furnace roofs in recent years: (1) greater stability of the furnace structure; (2) use of temperature control; (3) slag control. Considerable advances have been made in the last few years as a result of co-operative effort by bodies such as the Open-Hearth Refractories Joint Panel, working under the ægis of the Iron and Steel Industrial Research Council and the council of the British Refractories Research Association.

A fairly complete history of a basic open-hearth silica brick roof[5] has been recorded, from the selection of the raw materials for the making of the bricks to the post-mortem examination of samples from the roof at the close of the furnace campaign.

The principal raw material was Bwlchgwyn quartzite. After initial crushing, dry grinding and mixing with a slurry containing a mineralizer, batch samples were taken for grading control and moisture determinations made. Pneumatic ramming of the bricks and modern drying and firing technique were employed. Specific gravity tests before and after firing indicated that pebbly varieties of the rock inverted to the low specific gravity forms (tridymite and cristobalite) more readily than the normal or non-pebbly Bwlchgwyn rock.

Maintained loads refractoriness-under-load tests at a constant temperature of 1,600° C. were made on the fired bricks. A small expansion at 25 lb./sq. in. and a small subsidence at 50 lb./sq. in. load in a one-hour test showed the suppression of permanent expansion by increased loading and suggested that little, if any, permanent expansion would occur in a roof loaded by its own weight. The permanent expansion of a number of the bricks, determined by heating for 2 hours at 1,500° C., showed good volume stability. Higher values were found for bricks of 2·31 specific gravity than for those of 2·32 specific gravity, although it would appear probable that the tridymite (sp. gr. 2·27) content of the lower specific gravity bricks would exceed that of the others and would tend to revert to cristobalite (sp. gr. 2·32) during the test.

Extensive temperature measurements made by means of rare- and base-metal thermocouples embedded in the roof and a radiation pyrometer permanently sighted on the inside centre of the roof gave a record of temperature fluctuations and temperature gradient throughout the campaign. From the records just prior to gassing the furnace, it was shown that the stack draught was sufficient to draw air through the roof when the stack damper was raised, the temperature near the outer face of the roof falling much more than that in the middle of the brickwork. The hot face of the roof fell from 600° C. to 350° C. in 10 minutes, but not into the range where spalling was likely to occur as a result of the β-α cristobalite inversion, although it was well below the β-α quartz inversion temperature.

The temperature records taken over a complete heat were particularly interesting and showed fluctuations as large as 200° C. during charging of the furnace, but fairly steady conditions during melting and refining. On tapping the furnace, the hot-face temperature rapidly fell 300-400° C. and this chilling appeared with an increased time-delay and diminished amplitude through the roof section towards the cool outer face. At a point 9 in. behind the hot face, the maximum cooling occurred some four hours after the event which initiated it.

Some doubt which has previously existed as to the true significance of temperature readings taken with a radiation pyrometer with flame in the furnace seems to have been clarified, by the observation that when the radiation pyrometer showed a fluctuation of about 50° C. at gas and air reversals, the thermocouple initially ½ in. inside the brick from the hot face recorded a slower fall of about 20° C. It thus appears improbable that the 'flame error' of the radiation pyrometer is more than 10-20° C. and frequent records showing roof surface temperatures in excess of 1,700° C. indicated that this temperature may actually be attained in working without visible damage to the bricks, although the fusion temperature of a seasoned roof has been placed at 1,650° C. The reason for this high-temperature stability of open-hearth roof silica bricks was shown to depend partly on the inhomogeneity of the brick. When a test was made on a portion of brick rendered more homogeneous by crushing to powder, the refractoriness appeared to be some 40° C. lower than before crushing. The high-temperature stability of the continuous cristobalite skeleton is also of undoubted importance, as has been noted in silica bricks from other portions of the furnace containing much greater quantities of ferrous oxide. The temperature gradient through the roof underwent a pronounced change during the first two weeks of the nineteen weeks campaign. The region a short distance behind the hot face became a better thermal conductor as 'seasoning' developed, so minimizing the temperature drop in this part of the brick. It has been further suggested that the size, shape and ordination of the crystals may influence the thermal conductivity so as to produce a change of slope in the temperature gradient near the 1,470° C. isothermal (transition from the grey cristobalite to the black tridymite zone).

Several analyses of the dust in the furnace atmosphere at various stages of the heat wave have shown that, during charging, the dust is mainly iron oxide, lime and dolomite; during melting, chiefly iron oxide and lime with lesser quantities of alumina and silica; and during refining, it consists mainly of lime with smaller proportions of iron oxide, alumina, silica and magnesia. The rate of dust production was highest during charging and least during melting, as might be expected.

The dust in the outgoing gases passes into the regenerators where slagging of the brickwork filling is caused. Analyses of the slagged surfaces of bricks from both air regenerators illustrated this attack.

At the end of the campaign, sample bricks were selected from certain areas of the roof for detailed laboratory examination. Chemical analyses of the various coloured zones generally confirmed the results of previous investigators. Sulphur trioxide and phosphorus pentoxide have not generally been determined in earlier studies, and this work has thrown some light on their occurrence in open-hearth roof bricks. Nearer the hot face, SO_3 was less than 0·2 per cent, but increased suddenly to nearly 0·6 per cent in the reddish cool end of the brick. The concentration of sulphur in this area is believed to have come from the furnace atmosphere, possibly during the making of certain free-cutting steels involving the addition of pyrites to the bath.

Phosphorus pentoxide remained fairly constant throughout the hotter half of the brick and then fell to a mere trace. Nowhere did the P_2O_5.CaO ratio approach that in the slag, nor were the positions of the two maxima coincident. This observation supports the view that the slagging agents in the furnace atmosphere contain but little furnace slag. Small amounts of lead, tin and copper were found in the roof brick, but the volatile zinc oxide was quite absent though abundant in the furnace flues.

Stalactites which formed on the underside of the roof, during the campaign, were found to resemble the hot face of the brick in composition, but the FeO.Fe_2O_3 ratio nearly corresponded with that prevailing in the cooler portions of the black tridymite zone behind. This region of the brick was found to be less refractory than any other.

There was a general decrease of porosity towards the hot end of the roof bricks, which is in accord with the findings of previous investigators. Calculation, however, showed that the weight of absorbed fluxes is insufficient to account for the observed fall in porosity, and it must be assumed that some of the fluid glaze formed on the hot face is itself drawn up into the pores of the brick.

The region between the black tridymite and yellow zones, found in used roof bricks, has been shown to be of very low permeability. Microscopical work has confirmed this observation and indicated the presence of a narrow glassy continuum between the silica grains.

Microscopical examination of thin sections cut from the various zones has confirmed the observations of other workers on the stability of the various silica allotropes. The particular allotropes and their relative abundance in any given area have also been studied by coefficient of expansion curves and X-ray diffraction methods.

The formation of a eutectic between mellorite (a complex lime - ferric oxide - silicate of garnet type) and silica (tridymite or cristobalite) melting at about 1,160° C. was observed and is a factor of importance in determining the life of roof bricks.

It has also been shown that furnace gases can pass through the brick, and sulphur compounds in the gases attack the glassy matrix forming ferric sulphate or ferric oxide, depending on the prevailing temperature.

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[1] "Second Report on Refractory Materials." Iron and Steel Inst., Spec. Rep. No. 28, pp. 13–99 (1942).

[2] "Second Report on Refractory Materials." Iron and Steel Inst., Spec. Rep. No. 28, 101 (1942).

[3] Swinden, T., and Chesters, J. H., "Dolomite Bricks for use in Steelworks," *J. Iron and Steel Inst.*, No. 2, 105*P* (1941).

[4] *Trans. Ceramic Soc.*, **33**, 104 (1934).

[5] "A Co-operative Investigation of the Factors Influencing the Durability of the Roofs of Basic Open-Hearth Furnaces". Report by the Open-hearth Refractories Joint Panel, *J. Iron and Steel Inst.*, No. 2, 203*P* (1941).

CAMBRIDGE SCIENTIFIC WORKER AND THE WAR

ALTHOUGH recent surveys of the utilization c science in the War have tended to concentrat upon the situation in industry and in Governmen service, it must be remembered that the universitie are carrying on a considerable volume of war researc in addition to their main function of teaching. critical review of the actual and potential wa function of university research laboratories in Grea Britain would provide a useful addition to presen information, and their position must certainly b considered in any national scheme for the co-ordination of research. It is opportune, therefore, that o July 20 the Cambridge University Branch of th Association of Scientific Workers convened a meetin to discuss these points as they affect Cambridge There was an attendance of more than a hundred and contributions were forthcoming from researc workers in most of the principal departments of th University.

A number of speakers reported on the genera experience of their laboratories, other members o which supplemented their remarks in the discussions. The situation obviously varies considerably fro department to department, but it is clear that som important difficulties are common to all. The mai shortcomings may be summarized as: (1) lack o really important or urgent war problems in som laboratories, and the difficulty of obtaining suc problems; (2) continuance of academic research or more frequently, occupation with 'pseudo' wa research; (3) difficulty of effecting contact wit workers in the same field in Government institution or in industry; (4) hampering effect of secrec regulations, which appear to be sometimes absurdl stringent; (5) lack of organized collaboration including pooling of equipment, between the University departments; (6) difficulty under the presen University regulations of employing Ph.D. researc students on war work, particularly secret work an work carried on by research teams; (7) absence o pooling of scientific teaching with the evacuate universities and colleges in Cambridge (the Cavendis Laboratory is a notable exception).

As was pointed out by the chairman, there ar many scientific workers in Cambridge engaged o secret work of national importance, and their worl could not be discussed at such a meeting. Hence th discussion possibly tended to place emphasis on th less satisfactory aspects of the situation. It is precisely these which most urgently need attention however, and the volume of work represented wa considerable.

The first two points are conveniently considere together. In the field of organic chemistry, fo example, many of the post-graduate research student are working on problems recommended by th Advisory Research Council of the Chemical Society It was stated that the majority of these problem are long-term problems related to the improvemen of the post-war prospects of the chemical industry there is considerable dissatisfaction about this. Man senior members having left to do war-work, a considerable amount of teaching is carried on by th junior members of the laboratory, and it is undesirable to transfer all of them to posts elsewhere The solution lies more in their being provided wit the right sort of problems to solve. The situation i markedly better on the physical or colloid chemical side, where work is being done arising largely out of Service requirements, although some of it is rather long-term in nature. In 'pure' biochemistry it might be argued that there are very few real war problems at all, and this has led to quite a few research workers either continuing with academic research or taking up what might aptly be called a 'pseudo' war problem. It is necessary for biochemists to branch out into the related and more immediately useful fields of nutrition, medicine, bacteriology, agriculture and industrial fermentation. Difficulties here are the sketchy organization of biochemists for war purposes and the generally unco-operative attitude of industry.

The difficulty of meeting or corresponding with colleagues engaged on the same or similar work was instanced by speakers from various laboratories. The official attitude is often one of discouragement or even surprise, and many workers seem to have to rely on chance personal contacts. The stringency of secrecy regulations is sometimes too great, and has the undesirable effect of hampering the progress of work by preventing discussion with other scientific workers attacking similar problems. It is often particularly difficult for university men to obtain the necessary collaboration with industry or with Government laboratories.

The position of Ph.D. students was touched on by several contributors to the discussion. It is necessary to decide whether such persons are students being trained in some specialized branch of science, or whether they should be regarded as scientific workers of adequate experience to carry out successfully certain specific pieces of war work. The general opinion favoured the latter course as being more in line with the urgent needs of the situation, but it was felt that a modification of the University regulations to meet this point is necessary. Provision for students to submit secret war work in a dissertation for a higher degree has been made with apparent success in other universities, notably Oxford. Apart from secrecy precautions, there are difficulties in assessing a student's work if he has been working in a research team or has been engaged on a number of small isolated problems.

The crux of the matter was brought out by one speaker who gave a definition of war research. Scientific work can only be considered as war work when it is *very probable* that it will give results which can be applied to *this* War. Any other form of research is either 'pseudo' war work, or not war work at all. In particular, the urgent need for technical advance in the present critical war situation must be realized. Probably the prime need is for individuals to appreciate their responsibilities to the nation, and themselves actively set about obtaining definite war problems. Difficulties, often considerable, do exist, but they must be expected and overcome. Many university scientific workers need to change their outlook and stop looking for a major research project in short-term pieces of work. Much of the difficulty arises because academic scientific workers are tempted too much to pick and choose their subjects for research. The essential thing now is the usefulness of the research, not its inherent scientific interest. They should be prepared to change over to completely new fields if there is little of direct application in their own, or even to take up work of a more routine nature. A man called up into the Forces has to learn a completely new art, so why not the man of science, who after all is in a sheltered position in the War ?

While the meeting emphasized the need for personal initiative and hard work on the part of the individual man of science, it was clearly in no doubt that the setting up of a national body with executive power to plan scientific work is long overdue. A resolution, which was unanimously carried, gave expression to this opinion by supporting wholeheartedly the demands for a Joint Technical Board or Technical Planning Committee "with executive authority to co-ordinate research, design and development", and pointed out the necessity for such a body having the closest contacts with rank-and-file scientific workers. The maximum effort of Cambridge men of science to help the war effort was promised, and it was urged that, subject to necessary conditions of secrecy, *all* scientific workers engaged on similar problems or employed in the same place shall meet regularly to discuss progress and plan future advance.

COBALT-NICKEL DEPOSITION

AN article in the *Electrical Review* of July 3 by C. C. Downie describes the developments which have taken place in the last three years on research into the deposition of cobalt-nickel alloy. This alloy is at least three times as hard as nickel itself, and is more resistant to corrosion than either cobalt or nickel alone. Moreover, the process is within the bright plating category which obviates the need for subsequent buffing or polishing. The nickel used is electro-refined wire or strip and is even purer than the product obtainable from the carbonyl process. The best metallic cobalt to use is that obtained by special reduction of the oxide, such as by the Kalmus process, which is completely free from carbon and practically all other solid impurities. For all smaller work it suffices to use nickel and cobalt inter-wound in the form of wire or strip, to present a uniform surface closely akin to a solid anode.

Nickel is analysed by the dimethylglyoxime method and cobalt by the nitroso-β-naphthol method. For initial experiments the cathode may be of platinum sheet, so that all features of the deposition at different current densities and concentrations of the two metals can be followed, before commencing operations. The deposits can be made very ductile, so as to bend or twist without any tendency to lift or peel, while what is known as 'double-plate' is rarely encountered.

Earlier work done by Fink and Lah proved the wide range of silver-white deposits which could be obtained from different cobalt-nickel compositions, which in combined chloride-sulphate baths can contain 55–75 per cent of nickel with 45–25 per cent of cobalt. Afterwards, Young and Gould found that the mixed bath can provide almost any desired composition of deposit at a current density of from 10 to 30 amp./sq. ft., with or without agitation. Researches by Brockman and Nowlen showed that the density can be increased to between 32 and 144 amp./sq. ft. with a different type of electrolyte. Advantage has been taken of a similar composition for the dual deposition in a bath consisting (in oz./gal.) of 26·1 nickel sulphate crystals, 4·7 cobalt sulphate crystals, 2 sodium chloride, and 3·25 boric acid, maintained at 20° at a pH value of 5·5–5·8 at a maximum of 30 amp./sq. ft.

This composition gives appreciable control of the two metals, for if the temperature of the bath be increased the proportion of cobalt will be increased with a corresponding diminution of the nickel. Alternatively, by increasing the speed of rotation of the cathode, the nickel proportion can again be decreased. To reduce the cobalt proportion the current density only need be suitably decreased, while by lowering the pH towards acidity the alloy deposited acquires directly an increased nickel content at the expense of the cobalt. The introduction of triethanolamine makes it possible to deposit almost any proportions of cobalt and nickel.

The composition of such alkaline baths (in oz./gal.) is 10·7 nickel sulphate crystals, 4 nickel chloride crystals, 4 anhydrous sodium sulphate, and 16 triethanolamine, together with a second solution composed of 10·7 cobalt sulphate crystals, and 13·5 triethanolamine. In the latter instance the temperature of the bath is maintained at 23° C. and the two solutions are added in measured proportions as required. The corrosion-resisting properties of the combined cobalt-nickel deposit by far exceed those of the constituent metals, while the range of hardness, ductility and toughness is still further increased. The last two mentioned qualities are of special importance in the plating of stereotypes, where brightness is of no great account. The printing surface must withstand wear for lengthy periods without deteriorating, in which respect cobalt-nickel deposit has been of great practical value. The same type of deposit has been applied to the manufacture of rayon and other artificial silks, to surfaces which are exposed to heavy wear in regular textile mills and in modern laundry practice. In various instruments, automatic machines, and the finer parts of acoustic devices, cobalt-nickel deposit is preferred on account of the wide range of physical properties available.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT CHEMIST (MALE OR FEMALE)—The Clerk and Manager, West Midlands Joint Electricity Authority, Phœnix Buildings, Dudley Road, Wolverhampton (endorsed 'Assistant Chemist') (August 14).

LECTURER IN ENGINEERING at the Walker Technical College, Oakengates—The Secretary for Education, Education Office, County Buildings, Shrewsbury (August 15).

GRADUATE LECTURER IN BIOLOGY at the Crumlin Mining and Technical College—The Director of Education, Higher Education Department, County Hall, Newport, Mon. (August 15).

ENGINEER AND SECRETARY TO THE ISLE OF MAN ELECTRICITY BOARD—The Chairman of the Isle of Man Electricity Board, Electric House, Circular Road, Douglas, Isle of Man (endorsed 'Appointment of Engineer and Secretary') (August 17).

GRADUATE LECTURERS IN MECHANICAL AND ELECTRICAL ENGINEERING at the Lincoln Technical College—The Director of Education, City Education Office, 4 Lindum Road, Lincoln (August 17).

ASSISTANT TO THE CHIEF RESEARCH OFFICER OF THE MENTAL DISEASE RESEARCH DEPARTMENT—The Secretary, The University, Birmingham (September 1).

UNIVERSITY CHAIR OF CHEMISTRY, tenable at the Royal Cancer Hospital—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (September 1).

DIETITIAN—The Secretary, University College Hospital, Gower Street, London, W.C.1.

GRADUATE ASSISTANT MASTER TO TEACH CHEMISTRY in the Bury Municipal (Evening) Technical College and **GENERAL SCIENCE SUBJECTS** in the Bury Junior (Day) Technical School—The Director of Education, Education Offices, Bury.

TEACHER IN ENGINEERING—The Principal, County Technical College, Gainsborough, Lincs.

SCIENTIFIC ASSISTANT (WOMAN), WITH KNOWLEDGE OF LANGUAGES AND UNIVERSITY STANDARD QUALIFICATIONS IN PLANT SCIENCE—The Deputy Director, Imperial Forestry Bureau, Oxford.

FORTHCOMING EVENTS

Wednesday, August 12

INSTITUTE OF CHEMISTRY (LONDON AND SOUTH EASTERN COUNTIES SECTION) (at Kodak Hall, Harrow), at 6 p.m.—Dr. J. Grant: "Chemist versus Forger".

Friday, August 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "The Figure of the Earth" (to be opened by Sir Gerald Lenox-Conyngham, F.R.S.).

Sunday, August 16

ASSOCIATION OF SCIENTIFIC WORKERS (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1), at 3 p.m.—Conference on "The Scientific Film and Scientific Film Societies".

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of the Marlborough College Natural History Society for the Year 1941. (No. 90.) Pp. 30. (Marlborough: Marlborough College.) 2*s*.; to non-Members, 5*s*. [217

Transactions of the Royal Society of Edinburgh. Vol. 60, Part 2, No. 17: The Genus Primula, Section Nivales. By Sir W. Wright Smith and Dr. H. R. Fletcher. Pp. 563–627. (Edinburgh and London: Oliver and Boyd.) 8*s*. [227

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 13, No. 3, December 1941. Compiled by Agnes Elisabeth Glennie, assisted by Catherine Alexander. Pp. iv+157–232. (London: H.M. Stationery Office.) 4*s*. 6*d*. net. [247

Other Countries

Scientific Publications of the Cleveland Museum of Natural History. Vol. 8, No. 4: The Infero-Gnathal Plates of *Titanichthys*. By David H. Dunkle and Peter A. Bungart. Pp. 49–60. Vol. 8, No. 5: A New Fossil Fish of the Family *Leptolepidæ*. By David H. Dunkle. Pp. 61–64+plate 6. (Cleveland, Ohio: Cleveland Museum of Natural History.) [207

Forest Research Institute, Dehra Dun. Leaflet No. 5: Note on a Hot Air Kiln for Seasoning Half-Wroughts of Shuttles, Bobbins, Helves, Picker-Arms, etc. By M. A. Rehman. Pp. ii+6. Leaflet No. 8: Wooden Poles for Overhead Electric Transmission. By V. D. Limaye. Pp. ii+3. Leaflet No. 11: Types of Timber Seasoning Kilns suitable for Drying Indian Woods. By M. A. Rehman. Pp. iii+6. (Dehra Dun: Forest Research Institute.) [217

Parliament of the Commonwealth of Australia. Fifteenth Annual Report of the Council for Scientific and Industrial Research for Year 1940–41. Pp. 107. (Canberra: Government Printer.) 4*s*. 9*d*. [217

Indian Forest Records, New Series. Silviculture, Vol. 4A, No. 2: Provisional Yield Tables for *Dalbergia sissoo*, Linn. f. in the Irrigated Plantations of the Punjab. By Bakhshi Sant Ram. Pp. vi+117–143+10 plates. 2·8 rupees; 4*s*. Utilization, Vol. 2, No. 4: Third Interim Report on Work under Proj. 8 (Testing of Indian Timbers for Veneers and Plywood). By the Forest Research Institute. Pp. v+77–106. 9 annas; 10*d*. (Delhi: Manager of Publications.) [227

Practical Applications of Recent Lac Research. Edited by H. K. Sen. Pp. iv+78+vi+19 plates. (Namkum: Indian Lac Research Institute.) [247

Smithsonian Miscellaneous Collections. Vol. 101, No. 17: Developmental Physiology of the Grass Seedling, 1: Inhibition of the Mesocotyl of *Avena sativa* by Continuous Exposure to Light of Low Intensities. By Robert L. Weintraub and Edward D. McAlister. (Publication 3685.) Pp. ii+10+1 plate. (Washington, D.C.: Government Printing Office.) [247

Smithsonian Institution. War Background Studies, No. 2: The Evolution of Nations. By John R. Swanton. (Publication 3686.) Pp. ii+23. (Washington, D.C.: Smithsonian Institution.) [247

Scientific Publications of the Cleveland Museum of Natural History. Vol. 5, No. 5: Description of a New House Mouse from Cuba. By Philip N. Moulthrop. Pp. 79–82. (Cleveland, Ohio: Cleveland Museum of Natural History.) [247

Bulletin of the American Museum of Natural History. Vol. 79, Art. 5: Results of the Vernay-Lang Kalahari Expedition—Larger Mammals of Bechuanaland Protectorate. By John Eric Hill. Pp. 367–390+plates 36–43. (New York: American Museum of Natural History.) [247

Catalogues

Methyl-Testosterone B.D.H. Pp. 2. Sulphaguanidine B.D.H. Pp. 2. Valogen: Vitamin 'B' and Mineral Tonic. Pp. 2. (London: The British Drug Houses, Ltd.)

Carbon-in-Steel Determination Apparatus: an Improved Ströhlein Type Apparatus for use in Accurate Estimation of Carbon in Steel to 0·01 per cent in about One Minute. (GT. 1332.) Pp. 4. (London: Griffin and Tatlock, Ltd.)

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UTILIZATION OF SCIENTIFIC AND TECHNICAL RESOURCES

IN the past few weeks, the movement for making fuller use of the scientific and technical man-power of Great Britain in the war effort has been increasingly to the fore. The question was raised in the House of Lords on July 29 by Lord Strabolgi, who expressed the belief that the work of the scientific men attached to various Ministries is departmentalized; the remedy he suggested is a scientific general staff, with wide powers. The Government reply, by Lord Snell, pointed out the difficulty of arranging for an advisory or executive body which would not be responsible to a Minister, although Ministers are expected to assume full responsibility for decisions taken. He said, however, that the Government is continually considering methods of improving the present organization for utilizing the scientific and technical resources of the country. Since then, Captain L. F. Plugge, secretary of the Parliamentary and Scientific Committee, and nineteen other members of Parliament of all parties, have tabled a motion for discussion in the House of Commons urging "the early establishment of a whole-time Central Scientific and Technical Board to co-ordinate research and development in relation to the war effort and to ensure that the experience, knowledge and creative genius of British technicians and scientists exert a more effective influence over the conduct of a highly mechanized war".

The present position with regard to this thorny subject was outlined in NATURE of July 15, p. 65, following upon a spirited letter in *The Times* from Prof. A. V. Hill. The Government's attitude was defined in more detail in the debate in the House of Commons on July 14, when Mr. Oliver Lyttelton, Minister of Production, made a statement on the work of his department. In reading that statement, it is important to realize that the question at issue is not the merit of the scientific work being done, which is indeed of a high order. The crux of the situation is not the standard of work in the departments, but what is happening strategically in the use of the work of all the departments together. It is the old charge of departmentalism and the need for some properly constituted authority, with technical knowledge, centrally placed, that can insist on getting the information that it wants.

The central issue is simple enough, and it was not confused in the two days' debate. Would a central scientific direction in place of the present scattered and unrelated efforts better enable the country to convert its brain-power into the methods and the physical instruments which, as the product of ideas, win wars ? The general trend of the debate was to give an affirmative answer. At present, scientific and technical control is entirely departmental and not central, and usually at a low level, subordinate to administration. For operations, as Prof. A. V. Hill pointed out, planning has been centralized in the Chiefs of Staff organization; for supply in the Ministry of Production; whereas research, design, development and quantitative planning of the use of technical resources are altogether unrepresented at the highest level.

Prof. Hill's contention that there is no central technical staff or individual to advise the Cabinet or the Chiefs of Staff directly on the scientific and engineering aspects either of operations or production, or to ensure, on their behalf, that design and development are efficient and far-reaching, was not disputed by the Minister of Production. Mr. Lyttelton's attempt to show that such central direction is unnecessary did not find much support, judging from the tone of subsequent speeches during the debate. The evidence of departmental overlapping, of failure to check advance or effort on wrong lines, to correlate results and make them generally available, of lack of stimulus to the right research and of means of bringing the most important issues to the Government, coupled with the conspicuous neglect to implement the recommendations of the Select Committee on National Expenditure which was repeatedly stressed, remain disturbing.

It is not merely that the main questions as to whether our scientific and technical resources are being effectively used as a homogeneous whole, whether the advice of our committees and advisers is taken, and whether they have the authority to get done the things they advise, remained unanswered. The questions raised in earlier debates in February and in March are still awaiting answers. Prof. Hill pointedly commented once more on the research and development side of work in the Admiralty, but there has been no reply to his inquiry on February 24 regarding the scientific panel which had then been sitting for nine months to examine the scientific and technical departments of the Admiralty. Nothing further was said as to the appointment of three of the ablest scientific people in Great Britain to undertake operational research at the Admiralty, and the suggestion of a director of operational research in the combined operational or general staff has been quietly ignored. "If statesmanship and strategy are not properly provided all the time with accurate knowledge of weapons and equipment, their functions, their limitations, their cost in man-power and material for production, and their availability, we are heading straight for destruction. An expert knowledge of modern arms and their interaction with one another in operations against the enemy is an essential part of the directing brain centre in modern, world-wide technical conflict." These words, with which Prof. Hill in his speech on February 24 built up his case for a General Staff with executive functions, including a technical section of young and able officers, proved prophetic in the light of disasters in Libya. That alone sufficiently endorses the plea for providing on the qualitative side some high-level central body to see that the scientific and technical resources of our departments and the country are properly and effectively used, and that all technical activities of the departments are critically examined and their defects rectified.

The uneasiness on this point will persist while there is such studied indifference to the critical examination of many aspects of production which is contained in the fifty or so reports of the Select Committee on National Expenditure. The work of that Committee has been one of the most striking vindications of the Parliamentary system that has come out of the War, and yet, as Mr. A. Edwards pointed out on March 25, scant attention has been given to its reports, either by the House of Commons or by departments. The same point was made repeatedly in the debate on July 15. Sir Herbert Williams reminded the House that the vital importance of close contact at all stages between those engaged in design and those engaged in production was emphasized in the Committee's Second Report presented on April 18, 1940. His emphatic protest against the failure of Governments and Ministers to give effect to recommendations carefully thought out and based on full evidence was strongly supported by Mr. Price as well as by Sir George Schuster, who quoted from the Prime Minister's own Romanes Lecture at Oxford in 1930 on the functions of Parliament in dealing with economic problems: "Economic problems . . . cannot be solved by any expression, however vehement, of the national will, but only by taking the right action. You cannot cure cancer by a majority."

That is equally true of production, and it is no use pressing for a central scientific directing council unless there is in the Government the will, the vision and the determination to compel action on the ascertained facts, no matter what departmental privileges or other vested interests and private considerations must be overruled. A great Minister must to-day be more than the great advocate of which Bagehot writes. We have to secure that everywhere in control of policy and action there are alert and creative minds alive to the inherent possibilities in technical advance and competent not merely to match and counter, but also to surpass the developments and innovations of the enemy. Those are the standards, not social status, by which we must measure the competence, efficiency and dynamic qualities of an individual or a department, and while we may welcome the Minister of Production's assurance that an investigation is being made into scientific organization, and that of the Minister of Supply regarding the equipment for scientific research under the Tank Board, as well as for development and for practical knowledge of all kinds, the latest developments in the organization of the Ministry of Production will by themselves not meet the situation, though they are welcomed and will be followed with a lively interest.

There is no evidence of any desire to insist on the precise form in which the need for central scientific direction should be met. Since the debate an important deputation from the Parliamentary and Scientific Committee has waited on Mr. R. A. Butler, chairman of the Scientific Advisory Committee and president of the Board of Education, and asked the Government to set up a full-time Scientific and Technical Board (NATURE, July 25, p. 116), which would bring together all the essential information that is available, to link up the scientific and technical direction of the departments connected with the War and to influence the War Cabinet and the Chiefs of Staff as necessary.

On a further point also Prof. Hill has clearly won support for his views. He has directed attention to the contrast between our own haphazard system and what is being done in the United States to ensure that the best scientific ability works with the high command. The growing importance of linking our production and resources as closely as possible with those in the United States, the very account of the formation and work of the Combined Production and Resources Board which Mr. Lyttelton gave in his own speech, emphasize the importance of improving organization and relations at this point. But there is no properly organized central agency for bringing together the work of all the missions to the United States. We cannot wisely allow the departments to continue individually to send their missions, not in contact with one another and not co-ordinated with each other's activities. With central technical direction, it would be easy to establish a central information bureau from which scientific and technical liaison could be conducted so as to ensure that departmental missions are at least in touch with one another and that people at the centre know what all of them are doing.

The latest report of the Select Committee on National Expenditure heavily underlines all that has been said in these debates about our lack of full use of scientific knowledge, our tendency to use it as a last resource instead of in the earliest stages, and of the need for what Mr. P. L. Horabin described as a Ministry of Efficiency. If in such matters the Select Committee can advance such a damning indictment of the neglect by the Ministry of Supply of the elementary technique, tools and principles of scientific management few will be so far reassured by the Minister's statements in the debate on production as to cease to press for further co-ordination in matters affecting the use of scientific or technical knowledge.

It is true indeed that we need to become as a nation more achievement-minded, and that the wise use of industrial psychology and effective personnel management in the factory might do much to see better results from the labour force already deployed in the factories. That, however, is only a special aspect of scientific management which industry has long been accustomed to employ, although as the Select Committee observes, only within the last twelve months has there been in the ordnance factories any organized labour management as it is understood in well-run private industry. What is in fact required in the whole field of production, in its qualitative and in its quantitative aspects, is the thorough-going application of exactly those principles of administration which private industry is accustomed to apply unceasingly: far-sighted planning; effective co-ordination and sound organization; effective machinery to ensure that action is taken in accordance with decisions and policy determined; systematic control of efficiency; and the clear delegation of responsibility and the endowment with and use of adequate authority at every point in the chain. Flexibility, decision and purposeful action, co-ordinated and inspired by wise leadership, these are the essentials in war production, and great as have been many of our achievements in the last three years, our effort halts of its maximum until their influence is felt in every phase of our war production and every corner of the national economy.

The attention now rightly being directed to the place of scientific and technical men in the war effort, and the scrutiny of our own organization to that end in the light of American experience, should not lead us to overlook the fact that failure to implement the suggestions or to utilize effectively the knowledge or experience of men of science are only one aspect of a general failing. The memorandum presented to the Minister of Production last March by the Council of the Institution of Production Engineers on "Increasing Production without Increasing Facilities", like the reports of the Select Committee on National Expenditure, testifies to this. Its suggestions for increasing machine activity, regarding the simplification of design, rationalization by standardizing on fewer types or by sub-dividing production between fewer firms, and the introduction of improved manufacturing methods, have for the most part already been advanced by the Select Committee or elsewhere, but it is clear that inadequate use is still being made of the services of the members of the Institution although their availability has long been brought to the notice of the Ministry.

Very clearly, matters cannot and will not be allowed to rest as they are. However capable the president of the Board of Education may be, he ought not to be asked to combine with his departmental duties and responsibilities those which the chairmanship of the Scientific Advisory Committee should involve if that body is to make the maximum contribution towards resolving the present hiatus between expert knowledge and effective action. Whether or not the plan of a joint Technical Board is adopted, it is essential that those responsible for effecting the necessary co-ordination should be freed from other duties and able to devote their full time to the work. The second essential condition is that, individually and collectively, the members of the co-ordinating body should possess the scope and the authority to exercise leadership, and not merely advisory functions. They must be able to compel attention to the scientific and technical issues that come before them, and to override any attempt at departmental delay or frustration.

The establishment of some such small body is the surest way of ensuring that the best use is made of the scientific and technical resources of Great Britain in all branches of the war effort. That establishment, and the steady functioning of such a board when established, will call for unceasing pressure and vigilance from the general body of scientific workers, as well as from that increasing section of the general public which is now becoming aware of the dangerous consequences which have flowed from the Government's failure to deal with departmentalism and to heed the repeated warnings of disinterested and expert opinion of all kinds in matters affecting the efficiency of production and the utilization of expert knowledge.

THE STUDY OF RACE

Race, Reason and Rubbish

By Dr. Gunnar Dahlberg. Translated from the Swedish by Prof. Lancelot Hogben. Pp. 240. (London: George Allen and Unwin, Ltd., 1942.) 8*s.* 6*d.* net.

Race and Racism

By Ruth Benedict. Pp. viii+175. (London: George Routledge and Sons, Ltd., 1942.) 7*s.* 6*d.* net.

NEARLY all proposed solutions of problems of zoological classification have been of provisional value only. Of all such problems, the discrimination of natural subgroups of modern man and the evaluation of their interrelationships must have been the most discussed and the most controversial. The relevant evidence is far more extensive for *Homo sapiens* than for any other species, but no agreement regarding its racial classification has yet been reached. Darwinism altered the course of the study, but it did not provide a solution. More recently, reconsideration has been necessitated by the rapid increase of knowledge regarding heredity.

Prof. Dahlberg's book provides a lucid discussion of those aspects of genetical fact and theory which have a bearing on the racial problem. It is not assumed that the reader has any acquaintance with the subject. The first half of the volume, dealing with the mechanism of individual inheritance in general, is followed by chapters on differences between human populations. Finally, the "rubbish" referred to in the title is discussed: this is the Nazi racial doctrine and its application to Jews in particular.

There is no other account of modern genetics which has the same scope, and it will be welcomed especially by anthropologists. While appreciating that the evidence in question is relevant, they may reflect that it serves rather to emphasize the complexity of their racial problem than to provide a solution of it. In common with many other geneticists who have recently discussed problems of group heredity in man, Prof. Dahlberg considers populations as "isolates", though it is admitted that "species are the smallest groups which have sharp boundaries". In fact, there is no evidence that any subgroup of the existing species of man was detached from all other subgroups at any period. The general rule is that the geographical distributions of anthropological characters show gradations, and they fail to make any abrupt distinctions between populations. The records relating to series of living people and skeletons fail to suggest that any biologically isolated communities have ever existed, and this is the peculiar difficulty of racial classification. In view of a descriptive situation of this kind, the anthropologist may feel disappointed when the geneticist remarks: "Unless a racial group constitutes an isolate, or was formerly one and is now in process of breaking up, it has obviously no special interest for us."

One kind of aid which genetical theory can give to those engaged in dealing with this involved problem is well illustrated by a discussion in "Race, Reason and Rubbish" of the stature of Swedes in modern times. As for several other European populations, the records show that there has been a secular increase in the average measurement since about 1850. This trend has often been attributed to nutritional and other improvements in the standard of living, though there are objections to such an explanation. An alternative one suggested is that the change has been a result of the breaking up of isolates. The tentative argument is:

"Stature depends on a number of genes which reinforce one another. It is reasonable to assume that different genes occur with different frequencies in different isolates. Through the break-up of isolates these genes have been spread out in single dosage. If tallness depends on dominant genes, the break-up of isolates must, therefore, bring about increase of stature." If this view is correct, then stature still fails to satisfy the ideal requirements of a character used for taxonomic purposes.

Scientific workers have been unable to reach agreement in defining the concept of race, or in deriving a particular racial classification. They have no core of established opinion regarding such questions which might have been incorporated in the educational tradition. This failure left the way open to those who supposed that group relationships may be inferred not from biological facts, but from the cultural evidence of early historical records and language distinctions. It was discovered later that the idea of race may be used (or misused) to serve the political purposes of national propaganda.

"Race and Racism" is concerned primarily with this last question. It is divided into two parts. The first gives a popular account of the facts regarding racial differences which are commonly set forth by teachers of anthropology. It deals with such questions as the physical characters used, their genetical interpretation, group differences in mental traits, and the effects of the migrations and minglings of peoples. The treatment of these topics adequately refutes certain misconceptions and falsifications of the evidence, but it leaves the impression that the concept of race is still ill-defined.

The second part of the book deals with "racism", which is said to be "the dogma that one ethnic group is condemned by Nature to congenital inferiority and another group is destined to congenital superiority". This is considered as a communal belief, like a religion, which must be studied historically. Its descent is traced through classical and medieval times to the age of European expansion, and on to the culmination reached in the Third Reich. It is convenient to have a single word to denote the idea of group antagonism, but it may be questioned whether "racism" is the right word. Race did not become a political cypher until it was used in the interests of particular nations during the decades following the Napoleonic wars.

In order to counteract its misuse, Dr. Benedict urges the plea voiced by all detached students who have seriously considered the matter. The need is for widespread teaching of the biological facts of race and their bearing on the origin and development of culture. It is emphasized that such teaching by itself could not be expected to go far towards fostering racial tolerance. To serve that purpose effectively, it should be part of a syllabus concerned with the functioning and ideals of a democratic social order.

Racial dogma had been of political significance in Germany in earlier times, but it was left to the Nazi party to adopt it as the basis of the avowed national policy. The form of the doctrine was specially adapted to excuse persecution of Jews. Beyond that, in fact, no attempt was made to apply the theory: when the henchmen of the Führer were selected, no regard can have been paid to the physical qualities said to indicate pure Nordic descent. But it must have been supposed that the ruse worked sufficiently well, for, otherwise, another would doubtless have been substituted for it. It was possible to exploit the idea of race for propaganda purposes because its scientific investigation had led to no precise and final results. By ruthlessly disregarding all inconvenient facts, it was possible to adapt the doctrine to the changing needs of the political scene. In essence it was anti-scientific and in application entirely unscrupulous. This is a question which might well be considered by those engaged in examining the social and international relations of science.

ACOUSTICAL FACTORS IN PLANNING BUILDINGS

Practical Acoustics and Planning against Noise

By Hope Bagenal. Pp. xi+146. (London : Methuen and Co., Ltd., 1942.) 7*s*. 6*d*. net.

IN buildings of almost every type acoustical problems may arise in one form or another, ranging from the avoidance of noise from neighbours in small houses and flats to the provision of good hearing conditions in concert halls and cathedrals. It cannot be repeated too often that acoustical requirements should be considered from the very beginning of planning, and should be given due weight compared with other factors which affect the general lay-out, form and construction of the building. Mr. Bagenal, writing for students, and also for builders and architects with practical problems before them, expounds this principle very effectively in the book under notice.

The avoidance of noise is often the main acoustical need. In small buildings it may only be the noise of neighbours or of the plumbing, but in larger buildings more sources of noise, such as lifts and air-conditioning plant, may have to be considered. Moreover, different types of building—hotels, offices, hospitals, etc.—present their own special problems. These and other buildings are considered in detail, and the most effective methods of avoiding noise in the initial planning, so as to minimize the need for special sound-insulating constructions, are explained. The methods of providing good sound insulation in partitions, and good insulation against impact noises in floors, are described, and details of practical forms of construction are illustrated.

The last half of the book is devoted to the other major acoustical problem, that of providing good hearing in auditoriums. Here the requirements are adequate loudness, absence of echoes (especially of concentrated echoes arising from focusing of sound by large concave surfaces), and reverberant conditions appropriate to the functions of the particular auditorium. These factors are considered both in general and with special reference to different types of auditorium ranging from the small committee room to the large concert hall.

The author is at his best in dealing with the practical aspects of his subject, and makes effective use of existing buildings in illustrating his points. The short chapter surveying the acoustical defects of modern building types is especially valuable, and could be read with advantage by all members of building committees. Acoustical requirements may conflict with other needs, but they must never be ignored in the hope that everything will turn out satisfactorily in the end. Attempting to design for a multiplicity of functions may lead to failure to provide satisfactorily for any one, and the author wisely advises against such features as suites of committee rooms with folding partitions to permit them to be thrown into one, or a greater and a lesser hall, communicating for large assemblies, but intended also for separate simultaneous use.

The weakest part of the book is that devoted to the theory of building acoustics, and the physicist will find much to criticize here. The 'phon' and the 'decibel' are old stumbling blocks, and Bagenal fails to surmount them successfully. His statement (p. 64) that "where noise measurements of the insulation of a wall or floor are made by comparing energies measured on the source side and then on the receiving side, that is, where they are *differences* between measurements, it is clear that either unit can be used" is quite wrong. At low frequencies the sound reduction in decibels may be very different from the sound reduction in phons ; the former, moreover, is independent of the absolute level of the sound intensity but the latter is not. Similarly (p. 88), the reverberation period of an auditorium is the time taken for sound to decay by 60 db., and is not in general the same as that for a sound of loudness 60 phons to decay to inaudibility. In the table on p. 97 the absorption coefficients of surfaces are specified as being in foot units. The absorption coefficient of a surface is a pure number and thus independent of any units, and the same coefficients are applicable whether areas are measured in square feet or square metres. (The units are rightly stated in dealing with persons, chairs, etc., for the numbers here are the areas of totally absorbing surface which would provide the same absorption.)

These defects are unfortunate in a book intended for students, and the theoretical grounding should be sought elsewhere. Nevertheless, the student, the builder and the architect will all find the book of great assistance, not only in indicating the methods of dealing with specific cases, but also in directing their ideas generally along the lines to be followed in approaching all problems in building acoustics.

N. FLEMING.

AUTOBIOGRAPHY OF AN INDIAN CHIEF

Smoke from their Fires

The Life of a Kwakiutl Chief. By Prof. Clennan S. Ford. (Institute of Human Relations, Yale University.) Pp. xiv+248+4 plates. (New Haven, Conn. : Yale University Press ; London : Oxford University Press, 1941.) 18*s*. 6*d*.

ONE of the interesting features of this book lies in the fact that it covers the period of the first impact of white civilization on the native culture. The story is told by Charley, a Kwakiutl chief, born before there was much change in the native mode of life. Owing, however, to his elder brother's admiration of the white people's civilization, Charley was sent to school where he learnt English, and was thus able to give an account of his own life-history. He must have been a man of exceptional intelligence as well as possessing the good memory which characterizes peoples who have no written language and therefore have to depend upon oral tradition.

Charley's story of his life is no mere catalogue of events, but a full and reasoned account that illustrates, as it goes on, the social and material culture of his tribe, and many of their customs appear under a new light with his explanations of their meaning. This method of presentation is interesting and gives one the feeling almost of personal contact with the tribe, but it has the disadvantages of a good deal of repetition and a sometimes cloying amount of detail. This, however, is probably unavoidable in the circumstances, as over-editing and precise arrangement would destroy its human touch.

Apart from the sequence of nurture from birth to manhood, perhaps the most interesting part of the book is that which deals with the ceremonial life of the Kwakiutl and especially with the holding of the potlach. Charley was a firm believer in these and was at great pains to describe their procedure and significance. Even after they were forbidden by law he continued to hold them, or their equivalents, and thus they are probably the last to be documented by an actual participant. The potlach was no indiscriminate distribution of gifts—usually blankets—but an ordered ceremony in which the rank of each guest was indicated by the number of blankets he received. Each important step in the life of an individual was marked by a potlach, and could scarcely be achieved without it. The more important the status of the donor, the larger the gifts, and thousands of blankets changed hands at a sitting. As a blanket represented wealth and could always be exchanged for other goods, a man's position could be estimated by the number of blankets he owned—or were owing to him, for frequently blankets had to be borrowed, at a high rate of interest, by a man who wished to give a potlach. Moreover, as a man expected, sooner or later, to receive back from each of his guests the same number of blankets that he had given them, a potlach ceremony might be regarded as a kind of investment with the goods still in active circulation instead of being hoarded uselessly. These blankets were originally of native manufacture, of woven cedar bark or of skin; but with the coming of the whites they were soon superseded by the Hudson's Bay Company's trade blankets, which could be obtained readily in exchange for pelts. Potlaches did not always involve the distribution of blankets, for money, canoes or other recognized articles might be used, and at the potlach that took place a few years after a wedding in connexion with the marriage payment by the bride's family, there was always a distribution of household articles—boxes, mats, baskets and such-like.

In spite of his association with white people which was lifelong though intermittent, Charley retained his belief in sorcery, which in his youth was widely practised. The sorcerer, as is usual, had first to obtain some samples of the personal belongings of the individual to be bewitched—such as hair or nail clippings—which were put inside a human corpse, if possible, or if not into the body of some dead animal, which was sealed up and exposed. Whatever happened thereafter to this body would affect the sorcered person, and at its decay the victim would die, unless someone found the corpse and removed the contents. Sorcery was a dangerous trade and liable to punishment by death if discovered, but it was carried on all the same, and Charley gives a good many examples of it throughout his narrative, including his own experiences when a love charm was worked on him by a woman.

Charley must have been one of the last of his tribe to undergo the rigorous initiation ceremonies then practised on boys, including the warrior's dance when twigs were inserted through his flesh and he was lifted by them and was also cut by knives. He said that he felt scarcely any pain at all; indeed the whole boyhood training involved a stoical attitude towards suffering, a trait he seems to have retained throughout his life, as when he was nearly seventy years old he insisted on undergoing two operations to his hand without an anæsthetic.

Perhaps the most important part of the book to students is the author's forty-page introduction, which gives a clear account of the Kwakiutl, their tribal customs and social fabric. Without this, Charley's narrative would lose much of its value, and it provides a concise summary of a North-western culture. As a book of reference, this volume's usefulness is impaired by the lack of an index.

K. Rishbeth.

DERIVATION OF PETROLEUM

Source Beds of Petroleum

By Parker D. Trask and H. Whitman Patnode. Report of Investigation supported jointly by the American Petroleum Institute and the Geological Survey of the United States Department of the Interior, from 1931 to 1941. Pp. xiv+566. (Tulsa, Okla.: American Association of Petroleum Geologists, 1942.) 4.50 dollars.

Although a great deal has been written concerning the probable origin of oil, relatively little has hitherto been published on the nature of the substances from which it is derived. This has been largely due to the scarcity of data relating to the organic constituents of sediments. In 1926 the American Petroleum Institute, recognizing the vital need for such information, instituted a comprehensive study of source beds. Afterwards, in collaboration with the United States Geological Survey, the Institute extended this study of lithified deposits to embrace all aspects of the problem of origin and environment of source beds of petroleum. Results of these investigations are fully reported in this publication and an indication is given of the lines on which further research might profitably be undertaken.

As a basis of correlation approximately 35,000 samples were examined, of which 32,000 were well samples and 3,000 were outcrop samples. Of these 14,000 were from California, 6,000 from the Mid-Continent, 500 from West Texas, 3,500 from East Texas Basin, 2,000 from the Gulf Coast and 3,000 from the Appalachian area.

The method of examination was to compare the properties of the sediments within 200 feet of the oil zones with those more than 500 feet away to ascertain if consistent differences existed. Because of the large number of samples, attention was focused on properties of sediments which could be determined rapidly and with reasonable accuracy. Eight properties studied were: organic carbon content, nitrogen content, reduction number, assay number, texture, content of bituminous substances, colour and calcium carbonate content.

It was found that the nitrogen-reduction ratio, which is the ratio of the assay number to the reduction number and is a rough measure of the degree of volatility of the organic constituents, had a fairly definite relationship to the occurrence of oil, this ratio being generally low in sediments closely associated with known oil zones and generally high in barren beds or in sediments remote from known oil zones. The ratio ranged mainly between 3·0 and 10·0, and it was concluded that formations in which the average ratio is less than 5·0 could be considered definitely favourable for the finding of petroleum; those in which it is 6·0 were regarded as encouraging; those in which it is 7·0 not particularly encouraging; and those in which it is more than 8·0 definitely unfavourable.

The investigation is not claimed to have solved the problem of source beds, though considerable progress has been made. It is suggested that future research should be more detailed and that special attention should be given to sediments which, because of their stratigraphical relations to known oil zones, are almost certainly source beds. Investigations of this character would involve special chemical and physical methods such as X-ray and ultra-violet ray studies, chemical analyses of organic constituents and determinations of the state of reduction by more refined methods than have hitherto been employed.

PSYCHOLOGICAL STUDY OF TWINS

Twins and Super-Twins

A Study of Twins, Triplets, Quadruplets and Quintuplets. By Prof. Horatio Hackett Newman. (Advancement of Science Series, No. 1.) Pp. 164+15 plates. (London, New York and Melbourne: Hutchinson's Scientific and Technical Publications, 1942.) 10*s.* 6*d.* net.

ALTHOUGH, as the Registrar-General's recent report on fertility shows, one out of every forty-four persons born alive in England and Wales is a twin or super-twin—to use Prof. Newman's convenient term for individuals born more than two at a time—plural births usually occasion surprise and sometimes consternation. It was natural that the first quintuplets known to have been reared should attract popular interest; but it was not anticipated that the Dionne children would rival Niagara Falls as an attraction for foreign visitors to Canada. In writing a book designed to sift fancy from fact and to give a popular account of scientific knowledge about twins and super-twins, the author is sure of a wide circle of readers. It is only possible here to touch upon a few aspects of such a work.

Of the twins born in the United States during 1890–1900, 26 per cent are estimated to have been monozygotic, and the author states that 3–4 times as many dizygotic twins and 6–7 times as many monozygotic twins are born dead as is the case for singly-born children. The 1938 fertility statistics of England and Wales have shown that probably 25·4 per cent of twins born were dizygotic, and that the proportion of still-born was 83 per 1,000 for twins of like sex, 63 for twins of unlike sex and 37 for singly-born children, a very different ratio which does not, however, comprise abortions. The twin frequencies in different countries, set out in Table I, leave the reader in doubt as to the period covered, and nothing is said as to the probable effect of differing maternal age distributions, which have changed rapidly in some countries. This table and the conclusions drawn from it may be misleading, for while Norway is given a frequency of 1·45 twin maternities in each 100, and Italy 1·16, the percentage frequency of multiple maternities in 1934–36 was 1·35 in each of these countries, as a table in the Registrar-General's report indicates. A higher frequency in Scandinavia than in the British Empire (United Kingdom 1·21, Canada 1·18, New Zealand 1·17, South Africa 1·10) or in the United States (1·17) seems to be established by recent figures, but otherwise no firm conclusion can be drawn.

The summary of recent facts about monozygotic twins reared apart and about the Dionne quintuplets is, perhaps, the best part of the book. After ten years of patient search twenty pairs of monozygotic twins who had been separated in infancy and brought up in different circumstances have been found, and studied. Of these, four pairs had experienced wide differences in education, and their discrepancies in intelligence quotient (Stanford-Binet) amounted to 24, 19, 17 and 12 points, whereas in the remaining sixteen pairs whose education had differed only slightly the average discrepancy was no more than that for monozygotic twins reared together. The author's conclusion that the intelligence quotient is not fixed by heredity alone but can be changed considerably by education is a useful corrective to the widely held belief that intelligence quotients are measures of innate ability which are scarcely affected by education or environment. Furthermore, it shows that some conclusions which have been drawn from comparisons between the average intelligence quotient of groups of people educated under widely different circumstances of time and place, as for example parents and their children, are invalid. Innate ability cannot respond fully to most intelligence tests unless there has been an adequate educational background. On the other hand, the maximum response to such tests obtainable by dint of education is definitely limited by capacity of genetic origin, and it is not surprising that, despite the well-nigh perfect conditions of upbringing of the monozygotic Dionne quintuplets, identical hereditary factors seem to be imposing very similar limitations of mental development upon them all.

ENGINEERING MATERIALS

Materials Handbook

An Encyclopedia for Purchasing Agents, Engineers, Executives and Foremen. By George S. Brady. Fourth edition. Pp. vii+591. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 35*s.*

THE sub-title of this handbook gives the clue to the mode of treatment of the subject matter, and so inactivates the critical faculty of anyone who would judge it as a strictly scientific work; but it may at once be said that the information provided, being accurate and clearly presented, will be most useful to the readers for whom it is intended. The author wisely keeps to facts and ignores opinions, and his assiduity in collecting and fashioning the information over a period of twenty years deserves high commendation.

Although errors and omissions are remarkably few, considering the magnitude of the work, attention may usefully be directed to some of them. It will be news to the modern educated engineer to learn that oxalic acid is made by the action of nitric acid on strong alkalis (p. 349), and even a fourth-form schoolboy will smile at the statement that the specific gravity of degras (unpurified wool fat) is about 92 (p. 162). No doubt the latter is an uncorrected printer's error, as also is the formula $NaSO_4$ for saltcake (p. 472), and the statement that benzyl bromide is made by mixing bromide and toluene (p. 63). Trade buyers, executives and foremen, in particular, are unlikely to be edified by the assertion that dextrine is "a starch with a smaller value of x in the molecule"; and though, as the author states, it was clearly impracticable to give references or quote authorities, one would like to have corroboration of the statement that acetic acid occurs in citrus fruits and vegetables (p. 5).

Among the few omissions noted is the absence of any reference to synthetic acetic acid and the manufacture of nitric acid by oxidation of ammonia. There is a great wealth of data concerning metals and alloys, but chemical materials are treated somewhat cavalierly; for example, only eight lines are given to methyl alcohol, fifteen to benzene and seventeen to 'alkalis'; in fact, a better title for the book would be "Handbook of Engineering Materials". British trade names are conspicuously few, but no doubt a limit had to be set to the size of the volume; as it is, no fewer than about 4,500 substances are dealt with, and this fact alone should ensure a wide and successful appeal among those who desire a reliable and reasonably up-to-date compendium of the marketable commodities used in engineering and allied industries.

E. H. Tripp.

MODERN STATISTICAL METHODS

The Fundamental Principles of Mathematical Statistics

With Special Reference to the Requirements of Actuaries and Vital Statisticians; and an Outline of a Course in Graduation. By Hugh H. Wolfenden. (Published for the Actuarial Society of America, New York.) Pp. xvi+379. (Toronto: The Macmillan Company of Canada, Ltd., 1942.) 5 dollars.

Sampling Methods in Forestry and Range Management

By F. X. Schumacher and R. A. Chapman. (Duke University School of Forestry, Bulletin 7.) (Durham, N.C.: Duke University Press, 1942.) 2 dollars.

THE contemporary population of the United States seems to have not only a taste but also a distinct genius for statistical research. It does not follow, however, that American mathematicians have at all uniformly shown a talent for expounding mathematical statistics. The contrast is one of the most interesting in contemporary science. Obviously it springs largely from the detachment and isolation of many mathematical departments from the fields of application; so far that expositors do not appreciate, or indeed even know of, the mathematical advances used in practice. This paradoxical situation has, of course, its lessons for other countries and for other disciplines.

Mr. Wolfenden has written an original book. It is scarcely what its title (on the cover) claims, a presentation of "The Fundamental Principles of Mathematical Statistics", but rather an introductory course of reading for actuarial students, and "an Outline of a Course in Graduation". This course, which occupies two thirds of the book, is divided into three sections: (*a*) history; (*b*) mathematics and interpretation; and (*c*) applications.

The stress laid by the author on the importance of history is most refreshing:

"I therefore believe it essential to the proper understanding of any subject to absorb the history of the mental processes which have guided its development. This study, accordingly, is framed on that conviction. It is hoped, however, that the arrangement used will enable the reader to acquire the background easily, and in a manner less destructive of imaginative interest than is so often inseparable from the teaching of history *per se*."

A text-book is often thought to be a suitable sarcophagus in which to lay undisturbed the embalmed remains of obsolete methods. One valuable use of a historical as contrasted with a mathematical section might be to separate the living from the dead. The contributions of the twentieth century have, however, suffered in Mr. Wolfenden's hands. "Student's" method is much ill treated, and I read with pain of the analysis of variance "arising from Lexis's theory, based in fact upon the 'correlation ratio' ". Such comments are not historical. I venture to suggest that the first two hundred papers, at least, employing the analysis of variance do not make any use of Lexis's theory, or of the correlation ratio; and, for such part as I had in developing the method, I was at that time strongly conscious of the failure of the methods developed by Lexis and Pearson to solve even the simpler problems of this type which they discussed.

Whereas Mr. Wolfenden's title seems to invite too wide a class of readers, Schumacher and Chapman's paper-covered bulletin from the School of Forestry at Duke University, entitled "Sampling Methods in Forestry and Range Management", might properly have been addressed to a much wider audience. It constitutes an altogether excellent introduction to modern statistical methods, and its success in this respect seems to flow directly from the fact that the authors' aims are not academic, but are concerned only with a competent planning and handling of this aspect of practical forestry.

The utmost care is taken to give the reader a clear grasp of the elementary concepts which all statistical work involves; but this does not mean that only unimportant ground is covered. Degrees of freedom are introduced in the first chapter; "Student's" method and inferences of fiducial probability appear in the second. Part 2 is concerned with direct estimates by sampling, introducing the effects of the finiteness of the population sampled; stratified random sampling; the simultaneous use of several variates; sub-sampling and representative sampling. Part 3, on indirect estimates, gives a thorough account of the uses of regression, not neglecting the use of weights.

An appendix includes technical notes on mathematical points requiring further discussion than that given in the text. In respect of the factor $\left(1 - \frac{n}{N}\right)$ used in the variance of samples from finite populations, I would suggest that the student can gain a clear idea of its origin from the circumstance that sampling errors only affect his estimate of that fraction of the whole which is not included in the sample. The technical note on this point thus seems unduly heavy.

R. A. Fisher.

MECHANISM OF METALLIC FRICTION*

By DR. F. P. BOWDEN and D. TABOR

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AN experimental investigation of the kinetic friction of non-lubricated metals has shown that, in general, friction cannot be regarded as a surface effect. Penetration and distortion occur to some depth beneath the surface, and the frictional force and the nature of sliding are both influenced by the bulk properties of the metals. The physical properties of the metals, such as their relative hardness and melting point, play an important part. In fact, it has been shown that the nature of the sliding and the value of the friction are largely determined by these factors, and it has been suggested[1,2,3,4] that the frictional resistance between unlubricated metals is due primarily to the shearing of the metallic junctions formed by adhesion and welding at the points of contact, and to the work of dragging or ploughing the surface irregularities of the harder metal through the softer one. Even if the metals are carefully polished and are made as flat as possible, hills and valleys which are large compared with the dimensions of a molecule will still be present on the surface, and contact will occur only locally at the summits of these surface irregularities. The formation of metallic junctions between the surfaces will, of course, take place with cold metals. It has been shown that when the speed is slow or when the surfaces are stationary, so that there is no question of temperature rise, the high pressures at the points of contact will readily cause local adhesion and welding.

If the load and speed are sufficiently great, the frictional heat may raise the local surface temperature to a high value, so that a softening or even melting may occur at the points of contact. The occurrence of these high temperatures may be demonstrated by measurements of thermal electromotive force[5] and by polishing experiments[6]. If the loads are relatively light or the sliding speeds are slow, the temperature is, of course, too small to affect sensibly the mechanical properties of the metals. This is made clear in the original papers, where the actual conditions necessary for high temperature have been determined; but it is emphasized here, since there seems to have been some misunderstanding on this point. Other workers[7,8] have reported that when the average sliding speed of the surfaces is slow, the momentary temperature rise is of the order of 30–50° C. These measurements are in sensible agreement with ours. There seems little doubt, however, that under many of the conditions of load and speed used in practice, the local temperatures reach a high value. Independent evidence for the occurrence of these high temperatures has recently been obtained by other observers [9,10,11]. These observations are of importance, since it means that, under these conditions, the frictional behaviour of the metals and of lubricant films on them will be determined not by their properties at room temperature but by their properties at the actual temperature of sliding.

The physical processes that occur during sliding are obviously very complex, but an attempt has been made to put this theory on a more quantitative basis and to make an approximate calculation of the friction in terms of the known physical properties of the metals. It is suggested [12] that we may, in general, write the frictional force F as $F = S + P$, where S is the force required to shear the metallic junctions and P the force required to displace the softer metal from the path of the slider. A simple theoretical treatment enables us to calculate, for sliders of different shapes and sizes, the values of F, S and P in terms of the shear strength s and the 'flow pressure' p of the softer metal. In general, it follows that $S = As$, where A is the real area of contact of the metals, and $P = A'p$, where A' is the cross-sectional area of the torn track. From this, $F = As + A'p$.

If the ploughing term P is negligible, we have $F = As$. When the load is applied to the surface, plastic flow of the softer metal occurs at the regions of contact until the area of contact is sufficiently great to support the load. With any particular metal, therefore, the real area of contact A is determined primarily by the load W, and $W = pA$.

Hence $F = W\frac{s}{p}$, and the coefficient of friction

$$\mu = \frac{F}{W} = \frac{s}{p} = \frac{\text{shear strength}}{\text{flow pressure}}.$$

A somewhat similar expression applied to the cutting of metals has recently been derived by Ernst and Merchant[13].

Friction of a Hard Metal on a Soft One

An experimental investigation was made of these relations for steel sliding on indium, which is a very soft metal. The experiments were made with cylindrical, hemispherical, and plane sliders, and S and P were evaluated separately. The sliding speeds were low, so that the metals were at room temperature. It was found that the experimental results were in reasonable agreement with the general theory. The relative magnitude of the two terms S and P naturally depends upon the shape of the slider and upon other factors, but it is clear, both from theory and experiment, that under many experimental conditions the ploughing term P is an appreciable fraction of the total frictional force.

Another problem that is of general interest is the relation between the frictional force, the area of contact, and the load. The early work of Coulomb and of Amontons led to the formulation of two 'laws': (i) that the frictional force is independent of the area of the sliding bodies; and (ii) that the frictional force is proportional to the applied load[14]. There has been some difficulty in explaining these laws, but experiments on the real area of contact between stationary and between moving surfaces offer a theoretical explanation of them[2]. In these experiments the area of contact between the metals was determined by measuring the electrical conductance between them, and the results showed that, in general, contact occurred only locally at the summit of the surface irregularities, so that the real area of contact was very small and was almost independent of the apparent area of contact. We should therefore expect that the frictional force would also be independent of the apparent area of contact.

The second law, which is often referred to as Amontons' Law, also presented difficulties, since it was usually assumed that when the load was applied the surfaces were deformed elastically. In this case, the area of contact and hence the frictional force would be expected to vary as the two-thirds power of the load and not as the first power[2,15]. The conductivity measurements, however, showed that the deformation of the surfaces is mainly *plastic*[2]. The metals flowed under the applied load until the area of contact was sufficient to support it. In the case of plastic flow, the area of contact is directly proportional to the applied load, so that the difficulty disappears and we should expect the second law (Amontons' Law) to hold.

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* Lecture given to the Royal Society of Victoria in March 1942.

With any particular junction or point of contact between the metals, one of two conditions may obtain:

(1) The strength of adhesion between the soft metal and the hard may be greater than the shear strength of the soft metal. In this case, the break will occur within the soft metal, and fragments will be left adhering to the surface of the hard one. If the fraction of the total area of contact over which this occurs be α, the frictional resistance due to these junctions will then be $s_1 \alpha A$, where s_1 is the shear strength of the softer metal and A is the real area of contact.

(2) The strength of adhesion at the junction is less than the shear strength of the softer metal. In this case, the break will occur between the metals, and the soft metal will not be wiped on to the harder one. The value for the shear strength of these weaker junctions will not necessarily be constant. It may vary from a value that approaches s_1 down to very small values. Let s_2 be the average value. Over the whole area of contact there will, in general, be junctions of both types, and the total shearing force S will be:

$$S = A\,(s_1 + (1 - \alpha)\,s_2).$$

This treatment has been applied to metals which differ in hardness. The same general considerations apply if the surfaces both consist of the same metal. This case is, however, more difficult experimentally, since it is not easy to evaluate separately the S and P terms. We may expect somewhat similar general conclusions to hold for non-metallic solids.

Effect of Contaminating Films

Under most experimental conditions, metal surfaces are covered with a thin oxide layer and other contaminating films. During sliding, these films are torn, many of the surface irregularities penetrate through them, and some metallic contact does occur. Nevertheless, we should expect that the adhesion and shear strength of the junctions would be less than that of the pure metal. Earlier experiments have shown that this is indeed so[16]. If the surface films are removed by outgassing in a high vacuum, the friction is increased to a high value (for example, for outgassed nickel or tungsten μ is increased from about 0·3 to 6). In the same way, we should expect that the deliberate addition of suitable lubricant films to the metals would again diminish the intimacy of contact and the strength of adhesion at the junction.

Although experiments show this, they also show that lubricant films are rarely able to prevent some metallic adhesion from taking place. The surface irregularities penetrate and tear through the surface film, and metallic seizure and damage occur. The total area over which this metallic seizure takes place is, of course, very much smaller in the presence of lubricants than in their absence. It is probable that the main effect of adding a lubricant is to decrease both α and s_2. The experiments suggest that with clean steel sliding on indium, α is very nearly equal to unity and s_1 to the shear strength of pure indium.

Intermittent Motion

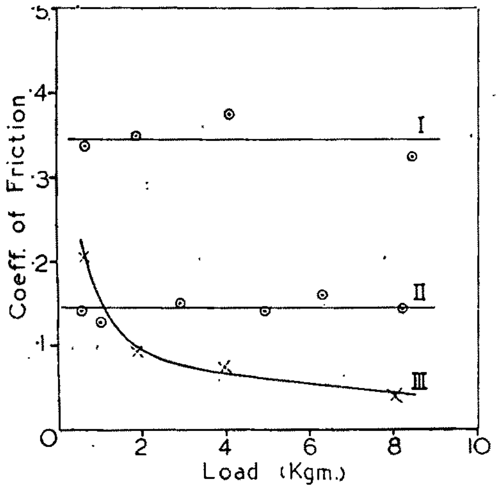
It has been shown that if one part of the moving system possesses an appreciable degree of elastic freedom, the motion may not be continuous but may be intermittent and proceed by a process of 'stick-slip'. This necessarily means that the kinetic friction during the slip is less than the static friction during the stick. It was found that with any particular mechanical system the type of sliding is profoundly influenced by the nature of the metals and of the lubricant films on the surface. The nature of the motion is also, of course, controlled by the mechanical properties of the moving system. Other workers[7,8] have recently repeated some of these experiments, using similar apparatus. They find results which are similar, but they lay particular stress on the fact that the motion is determined by the elastic properties of the system. This has, however, already been emphasized by us (compare ref. 3), where it is stated that the motion "will be influenced by the mechanical properties of the system such as the natural frequency, the moment of inertia, and the damping of the moving parts. Finally, it will be influenced by the velocity of the main forward motion." Since many moving systems possess an appreciable degree of elastic freedom, and since, in the limit, the surface irregularities themselves may be capable of a small elastic deformation, this stick-slip motion is of frequent occurrence provided the surface and other conditions are suitable.

It is not suggested that the occurrence of stick-slip is in itself proof that a lubricant is a poor one, although most poor lubricants give a motion of this type if the mechanical system will permit it. The nature of the sliding, the value of the friction, the damage to the surface and other factors must all be taken into account.

Friction of Metallic Films

In the earlier experiments, Amontons' Law held true, because a variation in the load automatically produced a corresponding change in the area of contact. It was not possible to vary them independently. This may be achieved artificially by using as the lower surface a hard steel substrate on to which a thin layer of a soft metal such as indium is deposited. A hemispherical slider is placed on top of this, different loads are applied, and the friction measured[12]. When the load is applied, the spherical surface will sink through the indium layer until the weight is supported by the underlying steel surface. Since the underlying steel surfaces are deformed comparatively little by the load, further increases in load will have relatively little influence on the area of contact between the slider and the indium. Provided a very thin layer of indium still adheres to the bottom surface so that little or no steel contact occurs, we should expect the frictional force to be almost independent of the applied load. This means that the coefficient of friction as usually defined by $\mu = \frac{F}{W}$ should decrease as the load increases.

Curve I shows the results obtained with unlubricated steel, Curve II with steel lubricated with a mineral oil and Curve III with steel on the surface of which an indium film 4×10^{-4} cm. thick has been deposited. In the first two cases, Amontons' Law is obeyed and μ is constant. With the indium film Amontons' Law breaks down; μ decreases as the load increases and reaches a value so low as $\mu = 0{\cdot}04$. This very low value of the friction is considerably less than that frequently observed with the best boundary lubricants and is similar to that obtained on ice[17].



Friction of curved slider on flat surface. Steel on steel (I) unlubricated, (II) lubricated with mineral oil, (III) with indium film 4×10^{-4} cm. thick.

The frictional force was determined by the real area of contact A between the steel and the indium. The load was important mainly in so far as it affected this area. In fact, for any given track-width the friction was the same on bulk indium as it was on indium films. If, however, very heavy loads were used, the films broke down: contact occurred between the slider and the underlying metal and the friction rose. Similar results were obtained with films of lead and copper deposited on the surface of other metals. It is interesting to note that Attlee, Wilson and Filmer[18] found that the steel ball bearings in a vacuum tube could be lubricated by thin metallic films of softer metals.

Effect of Temperature

With metallic films, the friction decreases steadily as the temperature is raised and reaches a minimum when incipient melting begins. This should be contrasted with the effect of temperature on the friction of pure metals[16], where the change in friction is very much less marked. This is to be expected, since with pure metals the shear strength decreases with temperature; but this is accompanied by a corresponding increase in the area of contact. With metallic films, however, the area of contact remains essentially constant since the load is taken primarily by the hard underlying metal. The decrease in shear strength of the film, therefore, leads to a decrease in friction. Once melting is complete, there is a rise in the friction, the magnitude of which depends upon the extent to which the molten metal wets the underlying surface.

In some ways, the behaviour of thin metallic films closely resembles that of lubricant films. They produce a substantial reduction in the friction, they can cause smooth sliding, and they protect the underlying metal surfaces. In addition, metallic films are worn off the surfaces by successive sliding over the same track in a manner similar to that of a lubricant film, except that the metallic films are worn away at a greater rate than the hydrocarbon films. A further point of similarity is the effect of melting. The transition from smooth sliding to stick-slips when the metallic films are melted is closely analogous to the change observed when solid hydrocarbon films are heated through their melting point[4].

There are, however, several marked differences between metallic films and lubricant films. The earlier experiments[4] showed that even on rough surfaces a lubricant film need only be one molecule thick to be effective as a boundary lubricant (see also Langmuir[19]). A metallic film must be appreciably thicker (*ca.* 10^{-6} cm.) if it is to be effective. A further striking difference is that lubricant films obey Amontons' Law whereas metallic films of this thickness do not. It is possible that with very smooth surfaces considerably thinner metallic films would be effective, and in this case Amontons' Law would be more nearly applicable.

The fact that under suitable conditions metallic films may act as effective lubricants is of some practical interest. It is suggested that the smearing of a thin film over the surface of a hard one plays an essential part in reducing the friction of many bearing alloys. Experiments which have been carried out on some of the copper lead alloys and on silver lead indium alloys lend support to this suggestion.

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TEA LEAVES AS A MAINTENANCE FOOD FOR ANIMALS

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IN these days, when the conservation and utilization of vegetable waste of all kinds is so urgently necessary, it is desirable that the possibilities of feeding spent tea leaves, which are produced in such large quantities, should not be overlooked.

Tea drinking has greatly increased in the United Kingdom in the past century; consumption rose from 1·4 lb. per head a century ago to 9·2 lb. before the War. The next highest rate of consumption per head of population was in the British Commonwealth, namely, Eire 8·2, Australia 7·0, New Zealand 6·7, Canada 3·6. Although total consumption in the United States was high, the rate was only 0·7, in the Soviet Union 0·2 and in Germany 0·2 per person.

It is obvious that in Great Britain the spent tea leaves provide a considerable bulk (roughly 200,000 tons before the War) of waste material which is available in most households and might be utilized, with other waste foodstuffs, for domestic animals.

An idea of the chemical composition of spent tea leaves is given by the following results of analysis of a sample taken from the urn and pots in the kitchen of Harper Adams College. The sample was found to contain 84·2 per cent of water and 15·8 per cent of dry substance, so that a pound of these wet leaves was equivalent to nearly 3 oz. of air-dry meal. The dry matter was found to contain 26·1 per cent crude protein, 14·2 per cent fibre, 1·2 per cent oil, and 4·6 per cent mineral matter. The high percentage of crude protein is probably deceptive since much of it is almost certainly in an indigestible form owing to the rather high tannin content of the leaves. In a test by the method of artificial digestion the dry substance was found to yield only 3·7 per cent of digestible protein. It is probable also that the tannin will tend to reduce the digestibility of the protein in other foods with which tea leaves may be mixed, and this point must be kept in mind in making up rations containing tea leaves. Broadly speaking, from the point of view of composition tea leaves may be regarded as a rough substitute for bran, though rather higher in fibre and lower in digestible protein.

TABLE 1. AVERAGE DAILY FOOD CONSUMPTION (oz.)

	Control			10 per cent concentrates replaced				20 per cent concentrates replaced			
	Concentrates	Green and roots	Hay	Concentrates	Tea leaves	Green and roots	Hay	Concentrates	Tea leaves	Green and roots	Hay
1st month	3·57	6·65	1·76	3·21	1·43	6·65	1·76	2·86	2·86	6·65	1·76
2nd ,, ...	3·29	7·71	1·60	2·96	1·31	7·71	1·60	2·63	2·63	7·71	1·60
3rd ,, ...	2·43	8·20	1·71	2·19	0·97	8·20	1·71	1·94	1·94	8·20	1·71
4th ,, ...	2·32	8·29	1·71	2·09	0·93	8·29	1·71	1·86	1·86	8·29	1·71
5th ,, ...	2·14	11·20	1·77	1·93	0·86	11·20	1·77	1·71	1·71	11·20	1·77
6th ,, ...	2·05	11·20	1·71	1·85	0·82	11·20	1·71	1·64	1·64	11·20	1·71
7th ,, ...	2·05	11·20	1·71	1·85	0·82	11·20	1·71	1·64	1·64	11·20	1·71
Average ..	2·55	9·21	1·71	2·30	1·02	9·21	1·71	2·04	2·04	9·21	1·71

There is a conspicuous absence of data on the use of waste tea leaves in animal rations, although it was indicated that they could be utilized as a result of feeding two small rabbits for very short periods (for five and ten days respectively) with 50 and 33 per cent of meal and bran replaced by an equal weight (30 and 25 gm.) of dried tea leaves. Another one was fed for two periods of ten days each with 33 and 50 per cent (20 and 30 gm.) of the meal and bran replaced by tea leaves. The same rabbit was fed for three days on powdered tea leaves without diminution of weight[1].

The use of spent tea leaves is no novelty to small-scale rabbit-keepers, but definite evidence as to their worth seems, however, to be very scanty, and therefore in view of the present emergency it was thought worth while to make some controlled tests in the Rabbit Section of the National Institute of Poultry Husbandry. The tea leaves were taken daily straight from the drainer and fed as soon as possible since they quickly go mouldy, especially in hot weather. They were readily taken by the rabbits, and their consumption reduced the intake of drinking water and stimulated the consumption of hay.

Tea Leaves in Growers' Rations

The first trial, of which a preliminary report has been given in the technical press, was carried out with thirty young rabbits, divided into three groups of similar weight (average 3 lb.). The control group were fed on green food, dry meals and rough hay. The other two groups were fed high proportions of tea leaves, 25 and 50 per cent of the concentrates being replaced on the basis of 4 oz. of tea leaves replacing 1 oz. of meal. It was found necessary to reduce the quantity of green food owing to undue laxativeness when used with high proportions of tea leaves. After one week on these diets the average weight gains per head were 4·5, 2·8 and 0·2 oz., but as the 50 per cent group had also dropped badly in condition the proportion of tea leaves for this group was reduced to a 12½ per cent replacement level, after which they soon recovered and then made satisfactory progress. By the end of the fourth week it was clear that even 25 per cent substitution was excessive, whereas those on 12·5 per cent replacement were doing well, with glossy fur and good bodily condition, and by the end of six weeks their average live weight had practically caught up with those of the controls, namely, 12·2 and 12·6 oz. respectively.

Briefly summarized, therefore, the first experiment with growers indicated that 12·5 per cent of the concentrates could be replaced by fresh spent tea leaves, but a 25 per cent level proved unsuitable between two and four weeks, and at 50 per cent it proved unsatisfactory within one week.

A second experiment was made with thirty more young rabbits, divided again into three groups of similar live weight and fed thus: group (4) on the control diet, (5) with 12·5 per cent of the concentrates replaced by fresh spent tea leaves, and (6) also with 12·5 per cent concentrates replaced by tea leaves but supplemented with fish meal in the ratio of 16 to 1 by weight to raise the protein level to that of the controls. The latter produced softer fæces than groups (4) and (5). Body condition and fur growth appeared to be similar 4–6 weeks later but, when handled, group (5) was not so good as the control or the supplemented tea leaves group; the latter were in good, firm condition. At the end of the sixth week of the experiment the average weight increments per head for the three groups were 12·3, 11·8 and 12·6 oz. respectively.

These results thus confirm the conclusion from the first experiment carried out that for growers, up to 12·5 per cent of the concentrates could be replaced by tea leaves.

Tea Leaves in Maintenance Rations

In a third experiment the object aimed at was to ascertain the extent to which this substitute foodstuff could be utilized in winter maintenance rations when other feeding-stuffs were in short supply. After a preliminary feeding period of two lunar months thirty adults, of average weight 7 lb. 7·6 oz., were divided into three comparable groups. Lot (7), the control group, was given a daily allowance per head of green food 7–11 oz., coarse hay 1·7 oz. and concentrates 3·6–2 oz., varied according to their condition and appetites ; lots (8) and (9) were similarly fed except that 10 and 20 per cent, respectively, of the concentrates were replaced by tea leaves (on the 4 : 1 basis) supplemented by 6 per cent of fish meal. The concentrates were fed generously in the early periods, when practically all stock was heavy in the moult, and were later reduced, more greenstuff or roots then being fed. The average daily food consumption in each lunar month is shown in Table 1. Owing to shortage in the supply of tea leaves during the College vacation, there was a break of three weeks in the feeding between the second and third months.

TABLE 2. AVERAGE LIVE WEIGHTS

	Control		Concentrates replaced by tea leaves			
			10 per cent		20 per cent	
	lb.	oz.	lb.	oz.	lb.	oz.
Initial live weight	7	7·60	7	7·50	7	7·70
1st month ..	7	8·20	7	3·60	7	6·80
2nd ,, ..	8	0·50	7	9·00	7	9·40
Resumed weights	8	2·20	7	10·30	7	9·50
3rd month ..	8	6·50	7	13·50	7	10·90
4th ,, ..	8	2·90	7	10·50	7	8·80
5th ,, ..	8	1·20	7	12·00	7	8·10
6th ,, ..	8	8·70	8	0·00	7	10·10
7th ,, ..	8	11·20	8	2·40	7	14·50
Actual aver. gain	1	1·90		9·60		6·70

From the live weight data summarized in Table 2 it will be seen that during the first two months the average gains in live weight per head in the three groups were 8·9, 1·5 and 1·7 oz. respectively, which suggests that the control ration was more than adequate for maintenance and produced a certain amount of fattening, while the two tea-leaves groups seemed little more than bare maintenance. After the experimental feeding was resumed at the beginning of the third month the differences over the remaining five months were much less (9·0, 8·1, 5·0 oz.), there being in fact little difference between the control group and the 10 per cent tea-leaves group, although the 20 per cent group was still substantially behind the others. Over the whole experiment the average weight gains of the groups with concentrates replaced by tea leaves were 53–63 and 37–43 per cent respectively of that of the control group.

The condition of the groups was mainly good to very good. The fur underwent great change, from heavy moult in all groups at the start, to a good, even, glossy fur in each group by 3–4 months later without any noticeable difference between different rations. The full winter bloom later faded as the breeding season came round. In the last month the does were mated and the feeding of tea leaves ended before the birth of the young. The numbers of fertile does in each group in this round of matings were eight, seven and nine respectively, so that the tea-leaves would not seem to have exercised any specific effect, either good or bad, on fertility. There were strong indications that the infertile does in all groups were associated more with strain than feeding.

As was to be expected, a much higher proportion of water was drunk by the control animals, with their somewhat larger quantity of dry food, than by those eating fresh moist tea leaves. The average daily amounts of water taken were 5·19, 3·26 and 3·26 oz. respectively. The water intake was also influenced by the quantity of roots and greenstuff which was fed. The animals on the tea leaves had damper floors, especially on the 20 per cent replacement, and required more hutch cleaning and caused some coat stain on the lower part of the body fur.

Briefly summarized, this experiment indicated that adult rabbits could be maintained in body condition on a ration in which 10–20 per cent of the concentrates were replaced by spent tea leaves (on the 4 : 1 basis). There was an increase of live weight in all groups, being greatest on the control diet, and lowest on 20 per cent replacement of concentrates by the tea leaves mixture. In neither case was there any adverse effect on subsequent fertility.

Acknowledgment is made of the helpful advice received from Dr. Charles Crowther in connexion with these experiments.

[1] Aruch, E., *L'Italia Agricola*, **57**, 17 (1920).

[2] King Wilson, W., *Fur and Feather*, **103**, 759 (1940).

BRITISH ASSOCIATION CONFERENCE ON MINERAL RESOURCES*

THE second day of the Conference convened by the British Association Division for the Social and Industrial Relations of Science on July 24–25 was marked by the presence of Sir Stafford Cripps as chairman of the afternoon session. In his opening remarks Sir Stafford alluded to his own experience of chemical research under Sir William Ramsay and to his contacts with scientific problems in the course of legal practice. It had been said that technical invention had outstripped social and political invention and means had still to be found by which the knowledge of the technical experts could be fully utilized in a democratic organization. It was not desirable that Parliament should be composed of specialists, the 'common jury' mind, capable of forming a general judgment on wide problems, being of great value, but that judgment had often to be formed on a basis of scientific evidence or technical knowledge. The Atlantic Charter was an attempt to express in easily understood terms the direction in which the political leaders of the democracies were looking for progress after the War had been won. It was clear that in its application a multitude of questions would be raised, requiring the best brains for their solution.

However perfect the planning of the future by experts might be, it would be of no avail without the determination of the peoples of all nations that it should succeed. It could be destroyed by a return to the old competitive struggle between nations or corporations in an attempt to win monopolies, and it would be necessary for the United Nations to undertake international regulation of the production and distribution of raw materials, in the interest of the devastated countries as well as with the object of attaining a rising standard of living throughout the world. The proposed international organization for the mobilization of all available knowledge of natural resources would be a valuable factor. The pooling of knowledge, already long customary in the field of research, must now be translated into co-operative action. The co-ordinated and planned action which had been essential during the War would be no less so after it, and the step from economic warfare to economic welfare would have to be taken. Science had shown the way to an economy of plenty, and its possibility had been made clearer by the events of the War.

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* Continued from p. 173.

At the morning session the chairman Dr. C. H. Desch, spoke of new metals and new methods. The importance of the influence of small additions of special elements to metals on their properties was illustrated, not only by the example of the alloy steels but also by such applications as the hardening of copper by beryllium and the strengthening of lead by so little as 0·05 per cent of tellurium. Novel combinations of metals led to such remarkable products as the newer permanent magnet steels, containing nickel, aluminium, cobalt and copper, giving such a high concentration of magnetic energy that a bar could be made to float in air in consequence of repulsion by another magnet, and revolutionizing the design of loud-speakers and measuring-instruments. The growing importance of metals of high melting-point, especially tungsten, had led to new techniques, such as 'powder metallurgy', and to the development of the high-frequency induction furnace and of refractory materials far superior to those in general use. Vacuum melting and also the use of exceedingly high pressures would become progressively more important, and called for new materials and new methods of construction.

The substitution of one metal for another, as of a light alloy for steel in the building of ships or bridges, usually involved new problems of design on account of differences in elastic and other properties. Chile saltpetre had been replaced by synthetic nitrogen compounds, and the rapid development of the plastics industry had made possible the replacement of metals for a number of purposes, but such substitutions did not necessarily lessen our dependence on mineral resources. Electric power for nitrate synthesis might be obtained from water, but in some highly industrialized countries had to come from coal, while many of the plastics were derived from coal or petroleum, although, being organic substances, there was always the possibility of preparing them from vegetable sources, for example, through alcohol.

Two papers dealt with sea-water as a source of minerals. Dr. E. F. Armstrong reviewed the problem generally. Salt had long been prepared by the evaporation of sea-water, but more recently the demand for bromine for the manufacture of 'Ethyl' for addition to petrol had led to the recovery of that element, especially in America, where it was blown out of the sea-water by a current of air after displacement by chlorine. Magnesia was recovered in large quantities by precipitation by lime or by calcined dolomite, and the industry had assumed large proportions in Great Britain as well as in the United States. Magnesium, although very abundant in the earth's crust, had only lately assumed great economic importance. It was extracted either by electrolysis of the anhydrous chloride or by thermal reduction of magnesia by calcium carbide, ferro-silicon, or carbon, the last of these presenting special difficulties on account of the high temperature required and the reversibility of the reaction with carbon monoxide.

Since the products of the disintegration of all rocks ultimately reached the sea, most elements must occur in sea-water, although in a state of high dilution. Phosphates, the deposits of which were limited in amount and likely to become exhausted, were wasted in present methods of sewage disposal, Great Britain alone discarding the equivalent of 150,000 tons of rock phosphate a year. Some means might be found of recovering a part of this. Selective absorption of specific elements was now utilized in the various processes depending on base exchange, and a method of recovery of phosphates might possibly be based upon that principle.

Dr. Ernst Bergmann spoke of the Dead Sea, in which the concentration of salts was much higher than in oceanic waters, while the relative proportions of the several elements were very different. The concentration increased from the surface downwards, and for industrial purposes water was taken from the lower levels. At present only potassium chloride and bromine were extracted, Palestine being now the largest producer of bromine, but the high concentration of magnesium salts suggested the use of this source for the production of the metal, provided that electric power were made available. Deposits of phosphates were found on the Transjordanian shore of the Dead Sea.

Means of economizing in the rarer metals used in alloy steels were discussed by Dr. W. H. Hatfield. Since the principal steel-making countries were dependent on imported ores for such metals as tungsten, molybdenum, nickel and vanadium, the conditions of restricted supply in war-time made measures of economy necessary. From May 1940 onwards this problem had been dealt with by a Technical Advisory Committee, and the alloy steels covered by between two and three thousand specifications had been reduced to eighty-five categories, greatly simplifying the choice of steels. It was not always necessary to use the more highly alloyed steels, which could usually be restricted to the heavier masses, for which they were essential to complete hardening.

Another aspect of economy was dealt with by Sir Harold Hartley in a paper on the recovery of metals from scrap. While process scrap, re-used in the plants in which it originated, presented no difficulty, old scrap, from disused or worn-out material, was of a mixed character, and offered many problems of collection and classification. Changes in methods of manufacture and use, such as the repair of parts by welding and improved protection against corrosion, affected the quantities of scrap returning to the furnaces, and the importance of the careful segregation of scrap from alloys containing valuable elements was stressed, as it was by the previous speaker. The great difficulty of securing statistics of scrap and secondary metal was emphasized, the present statistical knowledge of this important question being very unsatisfactory.

The session concluded with a paper by Dr. David Williams on the mineral resources of the Soviet Union. The detailed survey, illustrated by a remarkable series of maps, does not lend itself to abstracting, but both the bulk of the estimated reserves and their wide distribution must have surprised many hearers. Potash salts and phosphates, besides the metallic minerals, were present in very large deposits.

The development of these resources within the last fifteen years had been exceptionally rapid, and although doubt might be expressed as to the validity of some of the Russian estimates of reserves, it should be recalled that there were still vast areas awaiting investigation. Tin and tungsten were deficient, but it seemed likely that the U.S.S.R. would become self-supporting in and even able to export large quantities of coal, iron, petroleum, manganese, platinum, magnesite, phosphates, asbestos, potash and sulphur.

The afternoon session was devoted to economic questions. After the opening address by Sir Stafford Cripps, Prof. J. G. Smith, speaking of international trade in raw materials, said that the arrangement by which certain countries only manufactured goods and exchanged them with other countries producing only raw materials had sometimes been regarded as permanent, but had shown signs of breaking down as old capitalist countries found themselves obliged to extend their agricultural basis, while countries rich in raw materials exported less and worked up more of those materials at home. It was argued that the tendency was for industries to become less dependent on the localization of raw materials, thus admitting considerations other than purely economic ones in the choice of a country's economic policy. The factors were, however, very complex.

Dr. W. A. Lewis, in a striking paper on some aspects of mining finance, confined his remarks in the main to mining in Africa. The ordinary investor regarded mining ventures as highly speculative, owing to the uncertainty of the quantity of ore in a given mine, the fluctuations of price of most metals, and also to the prevalence of fraud. Greater legal control of company promotion would be of service in increasing confidence. The financing of mining had fallen mainly into the hands of large corporations, which could spread the risk and also provide the necessary technical guidance. This 'grouping' system, paralleled by the 'managing agency' system of the Eastern colonies, was good from the investor's point of view, but had the disadvantage that an entire colony might find itself in the hands of one or two corporations, dominated by one or two rich men, since the capital of such corporations came only in small part from the private investor, and mainly from banks and large finance organizations. The Governments of Southern Rhodesia and Tanganyika had set up special funds for financing small mines, which still had a future, and this policy might be extended.

The large corporations, by eliminating competition, were able to make excessive profits, from which the colony derived little benefit. In 1937 the Trinidad mines earned in profits three times what they paid to their native employees in wages, the Gold Coast mines two and a half times, and the Northern Rhodesian mines twenty times, and when dividends of 100 per cent were announced, colonial peoples asked why European capitalists should take out the principal wealth of the country and leave so little. Sooner or later awakening nationalism would compel the colonial peoples to assume control of their own resources, and in the meantime taxation might be increased, or experiments made with joint control, as in the Belgian Congo and Dutch East Indies, where the capital was provided in part by the Government and in part by private enterprise.

Mr. Arthur Notman, taking aluminium as his text, suggested that there was no more fruitful source of international friction than a system of tariffs, exchange controls, and other arbitrary restrictions on freedom of trade. The existence of a great internal free trade market had been an important factor in the prosperity of the United States. Aluminium would play a leading part in the future improvement of communications, and reference was made to a possible policing of the world by an international air force.

The general question of planning and the mineral industries was dealt with by Mr. O. W. Roskill, who concluded that there must be a central international authority which would correlate the plan for the mineral industries with the requirements of other industries, and could be built up out of existing bodies. All nations must be included. Planning of production was meaningless unless accompanied by planning of distribution and consumption. The determination of prices by the free interplay of supply and demand was incompatible with such planning, and it seemed likely that prices would be increasingly related to costs. If such stabilization occurred, producers and manufacturers would not need to protect themselves against fluctuations. Organizations for each group of commodities and manufactured goods would have to control both exports and imports.

The last communication was from Dr. L. Dudley Stamp, who spoke on the exploitation of minerals in relation to national and world planning. It was necessary to distinguish between those minerals which were in limited supply and were removed as completely as possible in mining, such as coal, oil and most metalliferous ores, and those which were so abundant that only parts of the available deposits were likely to be worked, such as limestone, clay, sand and gravel. In international planning it was the first which was important. There was in general a cycle in the development of such deposits—exploration, exploitation and exhaustion. In the early stages there might be a mining boom, with a very rapid development, great increase of population, and sometimes much extravagant building. The period of steady exploitation might be short, as with alluvial gold or tin, or might last a century or more as in a coal-field. Towns might be built and the fact that their prosperity depended on the exploitation of a deposit forgotten. The period of exhaustion could cause great maladjustments and much human suffering. The recognition of the right of the nations of the world to share its mineral resources carried with it an obligation to accept responsibility and to share the burden of such readjustments as might be needed. Examples taken from the British Isles included the decay of the Cornish tin mines, the destruction of vegetation and fisheries by lead mining and smelting, the formation of a stony desert in Northamptonshire after the removal of iron ore from good agricultural land, and the familiar instance of derelict coal-fields. It would appear that mineral exploitation inevitably resulted in a need for restoration, whether of land or of the social structure of the community; that this restoration should be obligatory on those who derived benefit from the working of minerals, and that as the stage of exhaustion was unprofitable, there should be some provision, comparable with an amortization assurance, made while the work was in the flourishing stage.

The Conference closed with the passing of the resolution proposed by Sir Richard Gregory and quoted in the first article (p. 171).

C. H. DESCH.

OBITUARY

Sir William Flinders Petrie, F.R.S., F.B.A.

In NATURE of July 18, p. 84, the respective claims of Sir Flinders Petrie and the late Prof. Reisner to have been the greatest of all Egyptian excavators were here being discussed, and satisfaction was being expressed that the former was still in the land of the living. Now, so shortly afterwards, he has passed from us at the advanced age of eighty-nine, and the mournful duty has arisen of reviewing his achievements and of discussing the influence he exerted upon archæology in England and in the world generally. One outstanding merit must be emphasized at the outset: it would be difficult to recall a life so wholeheartedly devoted to the task its owner set before himself; no hardship, no lack of monetary resources could make him swerve from the purpose he pursued with an energy for which few have the physical endowment, and none could better have deserved the fame and the honours showered upon him, the latter culminating in the knighthood of 1923.

His was a distinctively British career, exhibiting both the strength and the weakness of an intense individualism, enhanced by a private education and (if the truth be told) undisciplined by academic training. All the more brightly shone forth his undoubted genius. Few have possessed so high a degree of flair, or have obtained such accurate results by such unorthodox means. The writer has been told he sometimes made his plans with the help of an old walking-stick, from the original length of which deduction was made for wear and tear. Be this truth or mere fable, certain it is that his plans display a very high degree of accuracy, as was discovered when one of his rivals thought fit to uncover afresh some of the Royal Tombs of the First Dynasty at Abydos, an undertaking which both in its scientific results and in the material finds proved sheer waste of the rival's time.

The trouble is that the cavalier methods Petrie pursued required the hand of the master, and could not so profitably be adopted by pupils. This suggests another point. No one in England has ever excited so much interest in Egyptology, or has introduced so many fresh workers into the field; some of them, like the papyrologists Grenfell and Hunt, were destined to win great fame, while others, as little academically trained as himself, drifted into field work as a sport and drifted out again a few years later.

There was one regrettable side to Petrie's attitude to his science which must not be passed over in silence. No philologist himself, he tended to discount the importance of philology and to foster in his assistants the belief in some sort of antithesis between philology and archæology. This was ill-judged, and resulted in a certain amateurishness with which some of his work, for example, his "History of Egypt", and many articles in his periodical *Ancient Egypt*, is stamped. Obviously the Egyptian archæologist should possess at least a competent acquaintance with the hieroglyphs, just as the most learned decipherer of papyri and inscriptions would be but a poor Egyptologist could he not claim a sufficient working knowledge of archæology. But this having been said, let us hasten to add that almost any defect could be pardoned in one who owned even three quarters of the skill, the devotion and the driving-power of this greatest of all the British excavators.

It has been thought the more excusable here to offer a personal assessment of Petrie's merits since the facts of his career are so well known, have received such wide publicity in the Press, and are also set forth in his "Seventy Years in Archæology" and his much earlier summary "Ten Years' Digging in Egypt" (1892).

For this reason also the rest of this account shall be confined to enumerating the greatest of his discoveries and to stressing the most important of his innovations in archæological method. He had been engaged but four years in the field when, with his work on the Pyramids of Gizah and on the city of Tanis behind him, he started digging on the site of what proved to be the Greek colony of Naucratis (1884). Already he had set new standards in archæology by his attention to the minutest details, by his recognition of the outstanding importance of pottery, and by his personal and sympathetic supervision of his native work-people. His striking presence and personality could not fail to imbue the latter with respect, while at the same time he possessed some of the quick-wittedness with which Kitchener proved more than a match for Oriental cunning.

The work in the Fayyum in 1888–90 brought much fresh knowledge of the Middle Kingdom, but was transcended in importance by the discoveries at El-Amarnah in 1891 and at Nakadah in 1894. On the former site Petrie unearthed the palace of Akhenaten, the heretic king, finding very valuable frescoes and smaller objects, while in the latter he came upon an entirely new culture not at first recognized by him for what it really was, namely, a prehistoric cemetery of vast extent and wealth. In connexion with these prehistoric remains he inaugurated one of his most valuable contributions to archæological method, a classification styled by him "sequence-dating". This consisted in segregating the main groups of pottery, ivory, etc., in superimposed layers, and since no inscriptions were present to supply definite dates, in placing them in sequence with numbers theoretically ranging from 1 upwards, but actually starting at 30 for the oldest known remains, and ending at 80 for the First Dynasty.

As regards the tombs of the Kings of the First Dynasty at Abydos, investigated with great skill and care during 1899–1900, Petrie was not the original discoverer, but the previous excavations by Amelineau had been disgracefully conducted, and Petrie's systematic clearing was salvage of the highest order. A comparatively small dig at Thebes in 1895–96 had brought to light a stela of the reign of Merenptah with the first and only hieroglyphic mention of Israel. In 1911–12 at El-Lahun, Petrie's assistant Brunton came upon a great treasure of Middle Kingdom jewellery, later unfortunately disposed of to New York instead of finding a place, as it should have done, in the British Museum.

The above enumeration of the most outstanding finds shows that it was not given to Petrie to chance upon such sensational discoveries as Carter's tomb of Tutankhamun or Reisner's reburial of Queen Hetepheres. Cumulatively, however, his contribution has been considerably greater, for the number of sites and the variety of the objects found are almost incredible as the outcome of a single lifetime. This inadequate statement would contain an unpardonable omission were not reference made to the constant and unfailing help rendered by Lady Petrie ever since their marriage in 1897.

ALAN H. GARDINER.

NEWS and VIEWS

Imperial Institute of Entomology

In the early part of the century the importance of entomology to the health services and to agriculture in the Overseas Empire was at last beginning to be realized. In 1909 the Entomological Research Committee of the Colonial Office was formed, with Sir Guy Marshall as scientific secretary. In 1913, when the Committee extended its outlook and became the Imperial Bureau, and later the Imperial Institute of Entomology, Sir Guy became director, and he has just retired; he has thus guided the fortunes of entomologists in the Government Services abroad for more than thirty years, ably supported by Dr. S. A. Neave, who has been assistant director since 1913. The period has seen great changes in the position of entomology in the Empire. From a few isolated workers, largely unaware of each other's work, or even of each other's existence, there has developed a small army of several hundred field workers; and much of this progress has been due to the Imperial Institute of Entomology. Instead of being completely out of touch with work elsewhere, the field entomologists have had the invaluable *Review of Applied Entomology*, which has summarized progress in agricultural and medical entomology for the past thirty years. It is difficult to-day to imagine how one got on without this journal.

Another great difficulty of the entomologist abroad was that of getting specimens identified. This problem was one of the first to be tackled by the Bureau, and for many years now the words "kindly identified by the Imperial Institute of Entomology", so frequent in entomological papers from all over the Empire, are a testimony of the great value of this work. No appreciation of the work of the Institute would be complete without mention of the Parasite Laboratory at Farnham Royal, from which useful parasites and predatory insects have been distributed to all parts of the world. Sir Guy Marshall has built up his organization with energy, with vision and with a sympathetic understanding of the difficulties of the man in the field; and now, on his retirement, he hands on the reins of government to his assistant director. Dr. Neave has succeeded to a difficult task in difficult times, but the work he has already done with the *Review*, with the *Zoological Record*, with the "Nomenclator Zoologicus" and in many other ways, leaves no doubt that the Imperial Institute of Entomology is still in capable hands.

Prof. William Peddie

The retirement is announced of Prof. W. Peddie from the Harris chair of physics at University College, Dundee, in the University of St. Andrews. Born in Orkney in 1861, Prof. Peddie was educated in Orkney and Edinburgh, and graduated in that University in mathematics and natural philosophy. A student of Prof. P. G. Tait and a lecturer in the Department of Natural Philosophy, Prof. Peddie obtained the degree of D.Sc. from Edinburgh. He has always taken a keen interest in the work of the Royal Society of Edinburgh, and has served on the Council and as vice-president. In 1907 he was appointed as Harris professor in Dundee in succession to Prof. J. P. Kuenen, the first occupant of the chair, and for thirty-five years has carried on the work of the Department of Physics. In addition to text-books on elementary dynamics and physics he has written works on colour vision (1922) and on molecular magnetism (1929), two subjects on which he has specialized, and he has frequently contributed the results of his work to Nature.

Prof. Peddie reached the conclusion that the Young-Helmholtz theory of colour vision is the simplest, but the mechanism proposed by them is not an essential part of the theory. The formal laws of action, and these alone, constitute the essence of the theory. A paper published in the *Philosophical Magazine* in September 1941 gives a summary of six years' work on magnetization in crystalline media. The results in general sustain Weber's theory, which originated almost a century ago. An appreciative reviewer of his book called the modern presentation "Peddie's theory". The theoretical aspects of physics have always aroused his interest, and in discussing in 1931 the philosophy of "As If" in physical science he wrote: "The idealist, if he is an investigator in physical science, cannot avoid acting upon the postulate of realism. Nothing else gives him a foothold for work. He has to regard the universe 'as if' it were real. All our philosophies are necessarily based upon postulate; all our science is founded upon faith."

Biology and Human Welfare

Speaking at a conference at Newnham College, Cambridge, under the chairmanship of Mr. L. J. F. Brimble on August 8, Sir John Orr outlined his conception of the place of science in the post-war era. Pleading for a clearer vision of the great new world, he said: "What we need to go for in the new world is not the application of physical science for the production of goods to get money-power, but the application of biological science to build better men and a better society." The first step in the new world must be the abolition of poverty, and we must concentrate on building men and women before we build new cities. Sir John expressed the view that the age which is now passing away is largely the age of physical science, with its inventions and discoveries, which have given us power over the forces of Nature. It is to be hoped that when this War is over the age of physical science will be replaced by an age of biological science—the study of life in all its manifestations. Reviewing some of the results of the age of physical science he pointed out that in spite of the new inventions and discoveries the standard of life up to 1840 or 1850 actually fell below what it was before. The reason was that instead of applying the new machines wisely men had applied them to produce goods to sell to get money. "It was not that men were individually bad," he said, "but their whole background was bad. The fundamental ideal of the age was bad and, not only that, men did not even have the vision to see that this system must inevitably collapse, as it did during the War of 1914–1918."

One could have predicted a few years ago that the present War was inevitable. Now it has come it is destroying the age of the application of physical science to the production of money-wealth. Money is losing its power. The age of physical science is being destroyed by the machines which the system itself created. The old ideas are going with it, and to talk of reconstruction in the sense of getting back to 1938 is to talk sheer nonsense. In spite of the fact, however, that they have been driven by the wrong ideal, the people of England are people with an extraordinary sense of justice and kindness. They still retain a grasp on their old religious and ethical ideals. It is because we realize that these ideals cannot exist with the type of world domination sought by Germany that the War is being fought. Sir John emphasized the fact that a first step in the new world must be the abolition of poverty in feeding, clothing and housing, and declared that in the future biological science will be applied much faster than it has been applied in the past. We must concentrate first on building men and women—particularly women. That is more important than building new cities. That can be done by the purposeful teaching of biological science, and if we apply the ideals of biological science in our teaching we shall find we are not very far off the Christian ideal.

Industrial Pest Control Association

A MEETING of representatives of firms in all branches of the industrial pest control industry other than agriculture was held in London on June 9. The firms represented included those interested in natural insecticide raw materials such as Pyrethrum and Derris of Lonchocarpus, manufacturers of basic chemicals such as ethylene oxide and cyanides, manufacturers of speciality products for insect and rodent control, and contracting firms primarily concerned in the application of insecticides, fumigants and rodent killers on industrial premises. After consideration of the growing need for industrial pest control measures, particularly in relation to food storage and the war effort generally, it was unanimously decided to set up a fully representative body to be known as the Industrial Pest Control Association. In the past two months the new Association, with forty members, has set up a strong executive committee consisting of: Mr. C. S. Kroger of W. Edmonds and Co., Ltd. (chairman), Mr. R. G. Berchem of Jeyes Sanitary Compounds Co., Ltd., Mr. F. H. Braybrook of Technical Products, Ltd., Dr. F. P. Coyne of Imperial Chemical Industries, Ltd., Mr. A. F. McIntosh of Thos. Harley, Ltd., Mr. S. F. Sprange of London Fumigation Co., Ltd., Mr. J. B. Wilton of Fumigation Services, Ltd.; Dr. E. Holmes of Plant Protection, Ltd. (hon. secretary). In addition, a small technical sub-committee has been set up, with powers to co-opt other representatives with special knowledge, to advise the Association on technical matters and to collaborate with Government departments and other bodies on matters of mutual interest. Inquiries should be addressed to the honorary secretary of the Association at Jealott's Hill, Bracknell, Berks.

Sir William Tilden, F.R.S. (1842-1926)

SIR WILLIAM AUGUSTUS TILDEN, the centenary of whose birth falls on August 15, is best remembered as an inspiring teacher and for his pioneering work in connexion with scientific teaching in the younger universities of Great Britain. At twenty-two he became a demonstrator in chemistry at the Pharmaceutical Society, at thirty science master at Clifton College, at thirty-six professor of chemistry and metallurgy in Mason College, Birmingham, and at fifty-two he succeeded Sir Edward Thorpe in the chair of chemistry at the Royal College of Science, London. He retired in 1909. Tilden himself wrote some autobiographical notes on his school days and his efforts to qualify as a teacher of science in an article entitled "Progress in Science Teaching", published in the Jubilee issue of NATURE (Nov. 6, 1919); while in his biography of Sir William Ramsay (1918) are to be found accounts of the movement by which Ramsay, Tilden and others in 1889 secured a Government grant of £15,000 for the university colleges of Great Britain. Tilden's books were mainly for the use of teachers and students, but he also wrote some on the history of chemistry. He published some sixty scientific papers. So early as 1884, in his study of the terpenes, he obtained a liquid isoprene which by contact with gaseous hydrochloric acid was partly converted to rubber.

Tilden was president of the Institute of Chemistry during 1891–94 and president of the Chemical Society during 1903–5. He delivered the Bakerian Lecture to the Royal Society in 1900 and eight years later received the Davy Medal. When presented with the Medal he remarked that "In the life of every true scientific man there came sooner of later a time when if he had the smallest amount of success he felt disposed like Archimedes to rush into the street and shout Eureka! Eureka! Those were the moments of real triumph, the moments when one felt that life held something that was very sweet". Tilden, who was born in London and was the son of a Bank of England official, was twice married, and died on December 11, 1926, at Northwood, Middlesex, in his eighty-fourth year.

A Founder of the Royal Horticultural Society

THE Royal Horticultural Society was founded at a meeting on March 7, 1804, at Mr. Hatchard's house in Piccadilly. First among the names of those present was the Right Hon. Charles Greville, whose biography forms the subject of a paper by the present assistant secretary of the Society (*J. Roy. Hort. Soc.*, 67, Pt. 7; July, 1942). Born in 1749, he was a friend of Emma Lyon, later the Lady Hamilton who was associated with Nelson, had a distinguished career in Parliament, built harbour works at Milford Haven, became a fellow of the Royal Society for his work in geology, and practised such wide cultural graces as are denoted by membership of the Society of Dilettanti. Among all this extensive interest he managed to make a specialist contribution to horticulture, being responsible for the introduction of *Lilium concolor*, *Pæonia suffruticosa rosea*, *Camellia japonica*, *Clinogyne dichotoma*, two varieties of Magnolia, and others. Greville's garden near Paddington is said to be the place where American blight first appeared, but its owner overcame this doubtful distinction by suggesting the spraying of fruit trees with lime-wash. The genus Grevillea was named in honour of this horticultural pioneer by Robert Brown.

Prevention of Heart Disease

IN a recent paper (*Bol. Of. San. Panamericana*, 21, 231; 1942), Dr. Hugo J. D'Amato, secretary of the National Department of Hygiene at Buenos Aires, states that diseases of the heart and circulatory system were responsible for 24 per cent of the deaths in Buenos Aires in 1939. A fourfold programme has therefore been devised involving respectively medical prophylaxis and care, influence on specific groups, and economic losses, social assistance and State action. As regards the first point, medical examinations are to be made in such centres as factories, government offices and schools, so that rsons suffering from heart diseases may receive rly treatment. These diseases produce their worst fects during the most productive period (generally ter the age of forty), and it is calculated that 100 illion pesos represents the social cost of early death d forced retirement of such persons. Social assist- ce should be given not only to the actual patients it also to needy persons who are burdened with eir maintenance. As regards State action, the rgentine Government has provided for a compulsory ate examination, and legal restrictions have been ade on the work done by persons suffering from rdio-vascular diseases.

ndocrinology in Montevideo

THE June issue of the *Boletín de la Oficina Sani- ria Panamericana* contains an interesting account the Institute of Endocrinology at Montevideo, hich was founded in 1937 and serves as a teaching, eventive, therapeutical and research centre. It under the direction of Dr. J. C. Mussio Fournier, ofessor of endocrinology in the Montevideo School Medicine, who was recently president of the econd Panamerican Congress of Endocrinology held Montevideo. The Institute possesses a staff of isiting nurses who regularly inspect the schools at ontevideo, and under the guidance of a school octor select for observation and treatment children uffering from endocrine disorders. A hospital is ttached to the Institute, consisting of three wards, r men, women and surgical cases respectively. he majority of the patients are suffering from ndocrine diseases, but other complaints in adults nd children are also treated.

1,000-kw. Wind-driven Electric Generator

A PLANT which is said to represent the first serious ttempt to study the generation of electricity by ind-power on such a scale that its practical and conomic possibilities may be judged, is described in *ngineering* of July 31. The plant consists of a two- laded wind-turbine and a 1,000-kw. alternator ounted on a pintle girder on the top of a lattice teel tower 110 ft. high, and it has been erected on he summit of a 2,000-ft. mountain known as Grand- a's Knob, near Rutland, in the State of Vermont. hough in a sense the plant is experimental, the urrent generated will be used by the Central Vermont ublic Service Corporation. It has been estimated hat it will be possible to use the power of the wind or 4,000 hours a year. The blades of the turbine are ach 65 ft. long and 11 ft. wide and weigh 15,300 lb. he circle described by the ends of the blades is 75 ft. in diameter and at 28·7 r.p.m. the tip speed s 15·785 ft. per minute. The alternator is driven hrough gearing and generates three-phase current t 60 cycles and 2,300 volts. The designer of the ind turbine, Mr. P. C. Putnam, has had the assistance f others, and model tests of his turbine were made n the wind tunnel of Stanford University. There are any interesting features in the plant, and so that n exhaustive study of wind variations can be ade an anemometer tower 180 ft. high has been rected close by and fitted with three types of nemometers.

ecent Earthquakes

THE United States Coast and Geodetic Survey, in o-operation with Science Service and the Jesuit eismological Association, has found the provisional epicentre of the earthquake of June 29, which occurred at about 6h. 26·4m. U.T. From instrumental reports from eleven observatories, the epicentre turned out to be near latitude 34·5° S., longitude 70·5° W., which is south-east of Rancagua in Chile. This is definitely in a seismic district, and the depth of focus of slightly greater than normal is not without precedent near the Andes.

ON August 6 a severe earthquake began recording at 23h. 49m. 04s. U.T. A maximum ground amplitude of 800 μ was recorded at Kew on the vertical component seismograph on August 7 at *ca.* 00h. 25m. U.T. According to a tentative interpretation, the first impulse is a *P* wave, the *S* wave following at 23h. 59m. 15s. U.T on August 6, and according to the tables in use at Kew the epicentral distance would then be approximately 9,000 km.

Announcements

PROF. JAMES GRAY, professor of zoology in the University of Cambridge, and Prof. F. L. Engledow, Drapers professor of agriculture in the University of Cambridge, have been appointed members of the Agricultural Research Council in succession to Sir Merrik Burrell and Prof. D. M. S. Watson, whose terms of office as members of the Council have expired.

PRESIDENT ROOSEVELT has appointed the following committee to examine the whole field of synthetic rubber production and to report as quickly as possible: Mr. Bernard Baruch (chairman), who was the head of the War Industries Board during 1917–18; Dr. James Conant, president of Harvard University, and Dr. Karl Compton, president of the Massachusetts Institute of Technology.

A PANEL has been set up to inquire into the possibility of improving the ventilation of tanks either by use of refrigeration or by air conditioning. It is constituted as follows: Mr. S. A. Wood, senior scientific officer, Scientific Research Department, Ministry of Supply; Dr. Dorey, chief engineer surveyor, Lloyd's Register; and Dr. Ezer Griffiths, principal scientific officer, Physics Department, National Physical Laboratory.

THE Honorary Medal of the Royal College of Surgeons of England has been awarded to Lord Nuffield in recognition of his conspicuous service in assisting the improvement of natural knowledge and of the healing art and of his many liberal acts and distinguished labours inspired by the desire to advance the science and practice of medicine and surgery. The Honorary Medal was instituted a hundred and forty years ago, and this is the nineteenth occasion on which it has been awarded.

THE following appointments, promotions and transfers in the Colonial Service have recently been made: D. E. MacGregor, veterinary officer, Nigeria; F. Davidson, rubber production officer, Gold Coast; C. W. Lynn (agricultural superintendent), senior agricultural superintendent, Gold Coast; J. D. Kennedy (senior assistant conservator, of forests), conservator of forests, Nigeria; C. R. Petty (senior surveyor), deputy director of surveys, Gold Coast; H. R. Binns (veterinary research officer), senior veterinary research officer, Palestine.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Onset of Reproductive Phase in Grasses and Cereals

In the Gramineæ inflorescence production commences suddenly: the new primordia arising at the apex remain small but their axillary buds appear precociously and rapidly begin to develop into spikelets or groups of spikelets, according to the species. The abruptness with which vegetative growth changes over to inflorescence production suggests that there is a sort of minimum condition in the internal economy of the shoot apex which must be reached, and that once the point of balance is passed the vegetative type of growth ceases. The obvious suggestion is that the onset of the reproductive phase only occurs when a certain carbohydrate/nitrogen (C/N) ratio is reached. If this is the case, it should be possible to alter markedly the number of leaves produced before inflorescence production by altering the nutriment in which the plants are growing. Purvis[1], however, has shown that the amount of nitrogen supplied to rye seedlings has little effect. Plants grown under long days (16 hours) and manured with a full culture solution and 1/10 *N* culture solution produced 13·3 and 12·4 leaves respectively if germinated at 1° C. and 21 and 20·59 leaves respectively if germinated at 18° C.

I thought that the successive removal of the laminæ as they appeared might either lower the C/N ratio in the plant by cutting down the photosynthesis, or at least greatly lower the amount of food available for transport to the apex, using the term 'food' in its widest sense. It was thought that, as a consequence, the seedling might have to produce an increased number of leaves before inflorescence production commenced. As a test, grains from a single head of a pure line of wheat, *Triticum vulgare* var. *ferrugineum* Al. 'April Bearded', were sown in a large pot of good garden soil in mid-January in a cool greenhouse. (Thanks are due to Prof. Percival for original material from which the line was derived.) As the plants grew, those on one side of the pot had each successive lamina removed just above the ligular region immediately it was fully exposed. These plants could thus only photosynthesize by each developing lamina and by the sheaths left on the plant. As would be expected, the experimental plants were much smaller than the controls, as shown in the photograph taken on May 3, when most of the plants were gathered.

Although the two sets of plants differ so markedly in size, it will be seen from the results tabled below that the removal of the laminæ does not greatly influence the number of leaves produced before inflorescence initiation commences. Furthermore, if anything, removal of the laminæ slightly reduces the number of leaves rather than increasing them as was expected. The treated plants grew more slowly, and when collected, about a fortnight before the controls would have headed, were even then about three weeks behind. The reduction in the number of spikelets from 22 to 13–14 is clearly another indication of the starvation of the plants. It may be that this last effect is not merely due to a reduction in carbohydrate production, but at least partly to a decrease in the amino compounds available to the apex from the leaves. It may easily be that the removal of the leaves has not altered the C/N ratio of the apex itself but only reduced the amount of food present.

		Number of		Highest internode with basal	
		Vegetative leaves	Spikelets	Bud	Root initials
Control	1	12	21	8	8
	2	12	22	8	8
	3	12	22	8	8
	4	12	23	8	8
Average ..		12	22	8	8
Laminæ removed	1	11	12	7	6
	2	11	13	–	–
	3	11	14	8	8
	4	12	14	9	8
	5	12	15	8	8
Average ..		11·4	13·6	8	7·5

From these results, in conjunction with the observations quoted from Purvis[1], it would seem that it is impossible to make much alteration in the number of leaves which must be produced at the apex of a growing cereal like rye or wheat, either by altering the amount of nitrogen supplied to its roots or by greatly reducing its photosynthesis by the removal of large areas of assimilating tissue.

The stability of the leaf number at maturity in spite of drastic treatment is also apparent in Nutman's[2] study of plants grown from dwarf embryos of rye, where grains weighing only 2·3 mgm., obtained by early harvesting of the heads, gave plants with about the same final number of leaves as those grown from normal grains (about 36 mgm.).

Workers investigating the biology of cereals and grasses might well use the number of leaves on the main stem as an index of the maturity of the individual at any stage, since it seems to be more or less independent of maltreatment suffered by the plant.

B. C. Sharman.

Botany Department,
The University,
Leeds 2. July 21.

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[1] Purvis, O. N., *Ann. Bot.*, 48, 919 (1934).

[2] Nutman, P. S., *Ann. Bot.*, N.S., 5, 353 (1941).

Relative Toxicity of Insecticides

The mode of action of insecticides is still very obscure, and it often happens that their relative toxicity is largely dependent on the method of testing employed. Consequently it is difficult to compare the results of one worker with those of another.

Carefully planned standard methods are necessary, and we welcome the publication by Dr. Parkin of the technique adopted by the Pest Infestation Laboratory of the Department of Scientific and Industrial Research[1].

One point, however, might be criticized: it would seem unwise to rely on only one species of test insect. I have found that the relative resistance of insect species changes very much with different types of poison[2]. Therefore any one insect may not give a true indication of the effectiveness of a new insecticide.

In the Pest Control Laboratories of Messrs. Imperial Chemical Industries the difficulty is met by testing new samples on several pest species. Some interesting results emerged from testing even well-known poisons with a range of insects. Table 1 shows the relative toxicity to seven insect types of a variety of fumigants and vapour poisons.

TABLE 1. RELATIVE RESISTANCE OF PEST INSECTS*

Species	Stage	Median lethal dose (mgm. litre)											
		5 hr. exposure at 20° C.									1 hr. 25° C.		1 hr. 20° C.
		Benzene	Toluene	Trichlorethylene	Perchlorethylene	Carbon tetrachloride	Chloroform	Methyl acetate	Ethyl acetate	Ammonia	Hydrogen cyanide	Ethylene oxide	Sulphur dioxide
Ephestia kühniella	Pupa	243	>Sat.	299	>Sat.	>Sat.	387	—	—	—	1·6	37	—
Calandra granaria	Adult	213	90	251	101	592	359	70	99	8·9	22	17	10
Calandra oryzæ	Adult	183	76	219	90	473	254	38	36	7·3	24	12	31
Ephestia kühniella	Larva	152	62	204	91	448	255	44	50	7·7	0·4	26	16
Tineola bisselliella	Larva	137	55	176	86	352	215	—	69	—	6·5	18	24
Tribolium castaneum	Adult	64	33	103	50	137	181	65	68	5·9	0·6	41	17
Cimex lectularius	Adult	62	25	67	42	113	106	16	25	12	0·14	26	6·7
		Group 1						2		3			

*Experiments done in Pest Control Laboratories, I.C.I. Ltd. in 1939.

When this table is examined it is seen that the insects show the same order of resistance towards the various fat-solvent vapours (Group 1) but entirely different orders to the gaseous fumigants (Group 3). The explanation seems to be that an order of resistance is characteristic of a type of toxic action. The action of the fat-solvent vapours is mainly physical, whereas the highly toxic fumigants like cyanide undergo specific chemical reaction in the tissues. The two esters in group 2 would be expected to act like group 1 but are likely to be more readily hydrolysed in the tissues. It is interesting to find that the order of resistance to asphyxiation by carbon dioxide is the same as that towards the fat-solvent vapours (Table 2). (The exposures were made in glass phials, flushed through with carbon dioxide from a cylinder for five minutes and then sealed.)

TABLE 2. RESISTANCE TO ASPHYXIATION BY CARBON DIOXIDE

Species	Stage	Median lethal exposure (hr.)
Calandra granaria	Adult	213
Calandra oryzæ	Adult	68
Ephestia kühniella	Larva	54
Tribolium castaneum	Adult	30
Cimex lectularius	Adult	15

Returning to the general point, we see that *Tribolium castaneum* (Dr. Parkin's test insect) is relatively susceptible to the fat-solvent vapours and to hydrogen cyanide. But it is highly resistant to ethylene oxide, which would not appear to be a very promising fumigant judged by this species only. On the other hand ethylene oxide is more toxic to the *Calandra* spp. than hydrogen cyanide.

Contact poisons show the same specificity as fumigants. Thus, it has been shown that the house-fly[3] and the Aphids *Rhopalosiphum pseudobrassicæ*, *Aphis spiræcola*[4], *A. pomi* and *A. sorbi*[5] are more resistant to pyrethrins than to rotenone; while the reverse is true for the honey bee[5], the beetles *Epilachna corrupta* and *Diabrotica duodecimpunctata*[4] and the tick *Ornithodorus moubata*[6].

If the insecticides to be tested are merely pyrethrum solutions of different strengths, it is satisfactory to rely on one species, carefully reared as Dr. Parkin specifies. But if toxic principles other than pyrethrum are to be investigated, it would seem advisable to use more than one test species.

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July 23.

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[1] Parkin, E. A., NATURE, 149, 720 (1942).

[2] Busvine, J. R., *Ann. Appl. Biol.*, 25, 605 (1938).

[3] Le Pelley, R. H., and Sullivan, W. N., *J. Econ. Ent.*, 29, 791 (1936).

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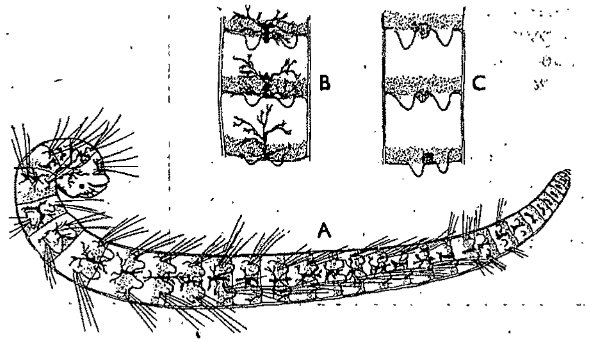
[6] Robinson, G. G. (unpublished).

Stellate Chromatophore in the Polychæta

THE stellate chromatophore has been chiefly studied in the Crustacea and Vertebrata, to which groups it was supposed at one time to be confined[1]. It is, however, present in leeches[2,3,4,5] and has been proved experimentally to contract in the dark and expand in the light. The purpose of this note is to show that the stellate chromatophore also occurs in polychæte larvæ. It may have an extensive distribution in the annelid phylum.

On the suggestion of Mr. G. P. Wells, who has kindly helped with this note and supplied details of literature, I made rough experiments at Plymouth with the larvæ of *Pœcilochætus serpens* Allen, which possesses stellate chromatophores noted first by Dr. E. J. Allen[6].

Structures resembling the vertebrate stellate chromatophore in appearance occur in many, but not all, polychæte larvæ. Wilson[7] found, in Polydora larvæ, that the chromatophores were sometimes expanded and sometimes contracted, but he made no experiments to determine the cause of pigment migration.



A. Pœcilochætus larva, 1·5 mm. long, from plankton, Plymouth Sound. Alive.
B. Chromatophores of same enlarged.
C. Chromatophores of another specimen kept in dark overnight.

I have been able to show that, in Pœcilochætus larvæ and in the larvæ of an unidentified Spionid, the chromatophores, which normally are expanded in the light, can be made to contract by keeping in darkness.

The worms taken direct from the plankton samples and showing branching chromatophores were kept in a cupboard in a finger bowl overnight. The next morning they were quite active and their chromatophores were contracted. The chromatophores appear to show "primary reactivity" of Hogben and Slome[8], as those of leeches do[5]. The worms were fixed in picric and mounted in euparol. The pigment in the chromatophores is almost black and shows no sign of dissolving in the permanent preparation. It is probably melanin.

M. V. Lebour.

The Laboratory,
Citadel Hill,
Plymouth.

[1] Parker, G. H., *Biol. Reviews*, 5, 59 (1930).

[2] Johansson, L., Bid Till Kännedomen om Sveriges Ichthyobdeller. Diss. Phil. Uppsala, I.R., 1896 (not seen).

[3] Stschegolew, G. G., *Rev. Zool. Russe.*, 7 (1928) (not seen).

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[5] Wells, G. P., Nature, May 7 (1932).

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Tracing Plane Spiral Coiling

Lieut. A. T. J. Dollar's letter on optical projection as an aid in studying plane spiral coiling of small fossil lamellibranchs[1] prompts me to point out a variation in technique which in the investigation of brachiopods gave superior results.

The study of a number of Lower Carboniferous brachiopods has forcibly suggested that the median or venter profile of the ventral valve is so constant as to be diagnostic of a given species. In arriving at this conclusion many accurately drawn venter profiles were compared. In the case of *Airtonia hudsoni* Cope[2], experiment on various methods of obtaining profiles, including that described by Lieut. Dollar, was made. The most satisfactory method was found in the use of an enlarging camera. The brachiopod valve was placed with the venter profile parallel to the surface of the bench, being held in position with a small block of 'Plasticine'. By careful adjustment on the vertical racking, a sharp image was obtained upon the ground-glass focusing screen of the camera. A small sheet of tracing-paper was secured in position in apposition with the screen and the venter profile traced with a pencil. Best results were obtained in a dark room using artificial illumination. Comparison of profiles was facilitated by having a separate small sheet of tracing-paper for each individual. The profile of the holotype for any given species was traced in coloured ink and taken as the standard profile.

By this method the position of the umbo can always be marked. Employment of the technique described by Lieut. Dollar frequently means that this important character is lost in the body of the silhouette.

In dealing with massive brachiopod valves such as those of *Daviesiella llangollensis* (Dav.), a different technique, which can be used when a laboratory is not at hand, was adopted[3]. An optical method could not be employed owing to the presence in many specimens of a ventral sinus. A piece of fairly stout lead-covered cable was obtained, the wire core with its cotton and rubber covering was withdrawn, and the lead tube slightly flattened. A mark near one end of the tube was brought into juxtaposition with the tip of the umbo of the brachiopod valve. The tube was then bent around the venter, care being taken that it was in contact with the valve throughout its length; the anterior margin of the valve was indicated by the production of a sharp bend. The curve so produced was laid upon tracing-paper and secured firmly on a drawing-board. A pencil line was then drawn along the inner periphery of the curve.

F. Wolverson Cope.

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250 Oxford Road,
Manchester, 13.
July 23.

[1] Dollar, A. T. J., Nature, 150, 57 (1942).

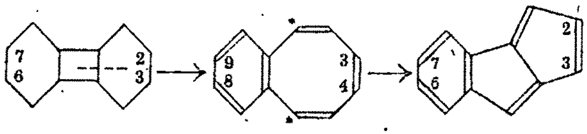
[2] Cope, F. W., *Ann. Mag. Nat. Hist.*, 14, 273 (1934).

[3] Cope, F. W., *J. Manch. Geol. Assoc.* (iv), 1, 201 (1940).

Structure of 'Diphenylene'

The preparation of diphenylene (I) by the action of sodium on 2 : 2′-dibromodiphenyl was described in 1911[1], but later workers have been unable to confirm this claim[2]. W. C. Lothrop[3] has recently described a different compound, $C_{12}H_8$, m.p. 110°, believed to be diphenylene (I), prepared by distilling either 2 : 2′-dibromodiphenyl, or, better, diphenylene-2 : 2′-iodonium iodide, $\{C_{12}H_8I\}$ I, with cuprous oxide. By the latter reaction he also prepared 2 : 7- and 3 : 6-dimethyldiphenylenes and found that the two products were identical; this was accepted as proof of the symmetrical structure (I).

The highly strained diphenylene molecule (I) is unlikely to exist, and consideration of the most probable course of the synthetical process employed by Lothrop leads to the conclusion that 'diphenylene' is the comparatively strainless tricyclic compound (III). The removal of the two halogen atoms will first give a diphenyl with free valencies in positions 2 and 2′. On the natural assumption that these valencies can only unite with simultaneous rupture of the potential *cyclo*butadiene ring (*cyclo*butadiene does not exist), see (I), the result will be to give a diradical of benzo-*cyclo*-octatetraene (II) (trivalent C atoms marked with *), which will rearrange into the least strained structure (III). This view of the structure of 'diphenylene' is in harmony with the identity of the two dimethyl derivatives, since both isomeric dimethyl-diphenylene-iodonium iodides must yield the same intermediate, the 4 : 8-(3 : 9)-dimethyl derivative of (II), and, therefore, the same final product, which may be either the 2 : 7- or the 3 : 6-dimethyl derivative of (III).



(I) (II) (III)

The preparation of 'diphenylene' by Lothrop's method has been confirmed. Catalytic reduction results in absorption of nearly three molecules of hydrogen, and thus it does not readily yield diphenyl as (I) would be expected to do. Moreover, it does not show the properties of an acetylene or an allene.

'Diphenylene' is the first known derivative of the partially aromatic system consisting of two fused 5-membered rings possessing four double bonds, a system first postulated by J. W. Armit and R. Robinson[4], and the preparation of which was attempted by J. W. Barratt and R. P. Linstead[5]. The double bonds in formulæ (II) and (III) are not fixed, and three uncharged forms of (III) may be written.

A full account of this work will be published elsewhere.

WILSON BAKER.

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University, Oxford.
July 2.

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[1] Dobbie, J. J., Fox, J. J., and Gauge, A. J. H., *J. Chem. Soc.*, **99**, 683 (1911); **103**, 36 (1913).

[2] Mascarelli, L., and Gatti, D., *Gazz. chim. italiana*, **63**, 661 (1933). Rapson, W. S., and Shuttleworth, R. G., *J. Chem. Soc.*, 487 (1941). Lothrop, W. C., *J. Amer. Chem. Soc.*, **63**, 1187 (1941).

[3] *J. Amer. Chem. Soc.*, **63**, 1187 (1941).

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Simplification of Musical Notation

As a result of a mess argument, in which two music lovers protested that the existing system of notation is too complicated, I endeavoured to produce a simpler method. The result was a 12-note arrangement instead of the customary 8-note one; therefore it would require 1½ times the space, using six lines per octave and a thick line for each *C*. The scale of *C* is shown, the arrow indicating the key note. In addition to doing away with sharps, flats and key signatures, when this method is used for keyboard instruments, the music is read in exactly the same way for both hands.

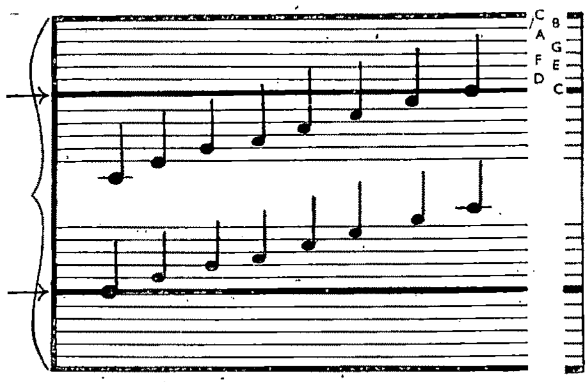
I see no reason why this system should not be applicable to all other instruments and lead to the abolition of special clefs for the instruments of the orchestra.

Some days later, I saw the interesting letters from Mr. Ll. S. Lloyd and Mr. K. B. Wood in NATURE of June 6, p. 640.

Like all readers of music, Mr. Lloyd reads a group of notes, not each individual note; this facility has been acquired by practice and experience. But what about the beginner? Which is the easier to grasp and eventually to understand and read—the 8-note plus accidentals method, or the plain 12-note method.

Mr. Wood's spacing takes even more room, but is splendid for keyboard use. I wonder if that can be dispensed with so as to make the system universal for all instruments.

Finally, I should like to point out, in defence of the extra lines required, the great steps that have been taken since plainsong was written on four lines. The extra line, sharps, flats and all the rest were added to the existing system, until it emerged in its present form. For equally tempered instruments we have had a 12-note scale for two centuries. For such free instruments as the violin and even the voice, the adjustment of each individual note depends entirely on the player or singer, who plays or sings to the pattern of the music, adjusting the pitch as dictated by his own ear. He could read this pattern from a 12-note stave and produce the key as harmonically correct as he could from the 8-note stave.



ALAN G. SMALLEY.

H.M.S. *Renown*,
c/o G.P.O. London.

Preparation of Deoxycholic Acid

THE problem of obtaining deoxycholic acid (3, 12-dihydroxy cholanic acid) in quantity has been rendered acute by present conditions, implying the closure of the sources (largely German) of pure bile acids. Isolation from bile is laborious and yields are uncertain. Since the acid is now widely used in bacteriological media, its preparation from cholic acid (itself easily obtained from bile) has been successfully undertaken. Cholic acid (3, 7, 12-trihydroxy cholanic acid) has been directly oxidized by chromium trioxide under controlled conditions to a mixture giving the semicarbazone (m.p. 250°) of 7-keto, 3, 12-dihydroxy cholanic acid in approximately 45 per cent yield. Reduction of this substance gives a 70 per cent yield of deoxycholic acid of high purity, identified by chemical and physical properties and oxidized to the well-known dehydrodeoxycholic acid (3, 12-diketo cholanic acid).

G. A. D. HASLEWOOD.

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London.
July 21.

THE ROYAL OBSERVATORY, GREENWICH

THIS year's Report of the Astronomer Royal refers to the work of the Royal Observatory during the period May 1, 1941–April 30, 1942. London suffered few air attacks during this time, and no further damage to the Observatory has occurred. Daylight observing is still carried on at Greenwich, but the larger instruments will, of course, remain dismantled for the duration of the War.

The public time service continues to function from two out-stations, each maintaining, in case of breakdown at the other, a complete time service involving transit observations, clock maintenance, and transmission of time signals to the Post Office and the B.B.C. The Rugby vernier signals, which are the precision British time signals, have up to the present normally been transmitted from Station *B*, since the clocks at station *A* are mounted in temporary fashion and suffer from serious mutual interference. During the year, however, the three free-pendulum clocks and a quartz clock at station *A* have been remounted in a specially constructed building, and it is hoped that their behaviour will now be sufficiently improved to allow this station to share regularly in the transmission of the rhythmic signals. The published corrections to the Rugby signals and to foreign signals are now based on some or all of nine clocks—seven Shortt clocks and two quartz oscillators—mounted in various parts of the country. By working on a "mean clock" and by making certain changes in the routine of signal transmission, a distinct advance has been made in the precision of the Rugby signals, the value of which as a day-to-day frequency standard has thereby been increased. Accurate allowance for land-line lag is now made before each signal is transmitted. Comparison of the signals against the clocks, or of one clock against another, is now facilitated by the use of thermionic panel units which eliminate the variation of lag inevitable with mechanical relays. Intercomparison of the clocks has shown that in the matter of small erratic changes of rate even the best free-pendulum clocks are inferior to quartz clocks.

The Chronometer Depot has settled down into its new quarters, and repair, rating and issue of chronometers and watches to the Royal Navy have continued without interruption. A vibration machine constructed in the Observatory workshop has been brought into use for testing aircraft watches under service conditions. Tests of the effect of magnetic fields of strengths up to 8·5 gauss on the rates of chronometers and watches have been instituted, no doubt with war conditions in mind, and are now nearing completion.

The last report of the Observatory stated that work with the Airy transit circle had been terminated after ninety years continuous observation. Since then, news has been received of the destruction of Poulkovo Observatory during the bombardment of Leningrad. This will be such a serious loss to fundamental positional astronomy that observations are to be resumed with the old Greenwich instrument on a restricted programme, including particularly transits of the sun. Minor damage to the housing of the instrument has therefore been made good, the instrument has been overhauled, and work will be resumed shortly. Analysis of previous observations with this instrument arranged according to wind direction shows that declinations south of the zenith are measured larger by about $0{\cdot}10''$ when the wind is north-east than when it is south-west. The observations of latitude variation had already given a similar result. This agreement shows the advisability in positional astronomy of applying locally determined latitude variations so as to eliminate spurious annual terms due to systematic seasonal fluctuations in wind direction. The division errors of the fixed circle of the new reversible transit instrument show on analysis a cyclic error, recurrent every $2\frac{1}{2}°$, which may reach $0{\cdot}19''$; thus emphasizing the need of determining the division error of each graduation.

The photoheliograph observations show that the expected decline in solar activity continues, though there have been four notable periods of resuscitated activity. Of the four big spot groups the area of which exceeded 1,000 millionths of the hemisphere, two exhibited bright eruptions in Hα light which were later followed by great magnetic storms on the earth. Assuming that the magnetic storms were caused by solar corpuscles emitted at the time of maximum intensity of the chromospheric eruptions, the mean time of travel of the particles is calculated as 20 hours.

The Nautical Almanac Office continues its essential work. Last year's report referred to the destruction by fire of the type and plates for most of its publications: during the early part of the year under review printing delays due to this circumstance and to a change of printing contract caused a dangerous accumulation of arrears. The Nautical Almanac for 1942 was in fact not published until November 3, less than two months before the date to which it refers, but the arrears are being wiped off so satisfactorily that the 1943 edition appeared on April 3. The failure of communications with many of the other ephemeris offices has led to a small increase of computational work; but duplication is avoided so far as possible by interchanging information with such of the offices as are still free to collaborate. The War has hastened a decision which would have been reached in any event, namely, to abandon the indiscriminate provision of occultation reduction elements. The observations for 1938 and 1939 show that the majority of the computed reduction elements are never in fact used, owing to the particular occultation not being observed; and of the remainder most are used once only. In future the Office will do the individual reductions for all observations actually made, provided that observers will do that portion of the reduction depending solely on their position and that of the star. A revision of the Air Almanac has recently been planned in conjunction with the Air Ministry: the effect will be to redistribute the data on the two pages allotted to each day, one of which now becomes a "night" page and the other a "day" page. The change should result in greater simplicity in use, at the expense of a slightly larger page. The present R.A.F. Star Charts are based on a recent investigation carried out by the Office on the optimum method of identification of the stars used in aerial navigation.

The Magnetic Department of the Observatory, in addition to the regular daily observations of the magnetic elements, is at present engaged in preparing charts for the Admiralty showing the iso-magnetic lines in declination, horizontal intensity, inclination and vertical intensity. The declination charts, of which the previous edition was published in 1937, are now ready; those for *H* and dip, for which the previous editions are dated 1922, are well advanced. Vertical-intensity charts are a novelty.

Features of the year's weather observed at Greenwich include a very wet August (4·146 in.) followed by an unprecedented lack of rain in September and October, during which only 1·41 in. fell. The winter was conspicuous for cloudiness, the sunshine recorded being only 55 per cent of the average, and for consistently low temperatures in January and especially in February, which had a record number of days twenty-six) on which temperatures below freezing were recorded.

Visitors to Greenwich Park will miss the famous 24-hour clock dial at the shattered main gates of the Observatory, and the daily fall of the time ball; but the familiar domes are still there, though somewhat perforated, and the Wren building still stands guard over the all too characteristic bend in the river. Meanwhile, as the familiar, never-failing "six-pips" testify, the work of the Royal Observatory goes on.

RELICT VEGETATION OF THE SHILLONG PLATEAU, ASSAM

AN account has been given by Dr. N. L. Bor, forest research botanist at the Dehra Dun Institute (*Ind. For. Rec.*, vol. 3, No. 6, Govt. of India Press, New Delhi, 1942), of the vegetation of the Shillong plateau. The broad divisions are evergreen forest, pine forest and grassland. The status of each type is discussed. An analysis of the evergreen species in three widely separated groves shows that floristically they are related. The conclusion reached is that the climax is the evergreen forest, while the pine forest and the grassland are seral in status. This is a bald summary by the author; for there is much that is fascinating, and some important lessons to be learnt from the record.

Shillong, the summer capital of the Province, is situated in the Khasi and Jaintia Hills district. The portion here dealt with is the elevated tableland stretching from Cherrapunji, reputed the rainiest pot in the world (900 in. have fallen in a single year), in the south to Shillong in the north; it consists of a wide plateau of rolling downs intersected here and there with narrow gorges and some 4,000–,400 ft. in elevation, the latter near Shillong.

The three great divisions of the vegetation are grassland, pine forest and evergreen forest, and here as in so many other parts of the world their disribution or survival has been due to man and his actions. Thirty years ago, the *Imperial Gazeteer of India* stated of the Khasi and Jaintia Hills: "At an elevation of 3,000 ft. the indigenous pine (*Pinus Khasya*) predominates over all other vegetation and forms almost pure pine forests. The highest peaks are clothed with clumps of oak, chestnut, magnolia, beech and other trees, which superstition has preserved from the wood-cutter". Both Hooker, 1849 "Himalayan Journals") and Griffith (1837) recorded heir impressions of the scenery, and both were truck with the bareness of the country, the great xpanse of grassland on the rolling downs. Bor tates that after the lapse of a century they have very much the same appearance to-day. The clumps of evergreen forest mentioned in the *Gazeteer* of thirty years ago also still exist, solely because they are regarded as sacred. Hooker has recorded that the flora of the Shillong plateau, in comparison with the area it occupies, is probably richer in the number of flowering plants than any other area similar in size in the whole of Asia.

The inhabitants of the plateau are of Mongolian stock and have maintained themselves intact for many centuries. By nature and practice they are shifting cultivators, termed Jhuming in Assam and Bengal. All the hill tribes in Assam live in this way, the most wasteful of all forms of cultivation. As Bor correctly points out, in the distant past when populations were small and forest areas extensive, little harm was done, but he writes: "it is a very different tale when the cultivators live in stationary settlements and their numbers continue to increase. What one may call 'saturation point' has now been reached by most of the hill tribes and one of their most urgent problems is that of the exhausted soil which must produce more at more frequent intervals. Some tribes solve this question by having permanent fields which they can irrigate, others manure their fields, while the Khasis go to the trouble of growing forests [of pine] which can be cut down and the area occupied by them cultivated".

Since the evergreen groves are sacred, it is the pine forest areas which are selected for cultivation. It is impossible to follow the author in his interesting descriptions of the methods used; he mentions that the introduction of the potato in 1830 has greatly increased the pine forest cultivation. Immigration by Nepali graziers, encouraged by the chiefs for the revenue they bring, has taken place for many years past and the graziers, says Bor, "are undoubtedly responsible for the devastation of forest over very large areas. In areas which were covered with forest a century ago, nothing but grassland remains, and on the whole it is very poor grassland. This grassland is composed of rather coarse species and it is fired by the graziers as soon as it is dry enough in order to obtain the new flush, which is eaten by cattle. Under treatment of this kind grassland degenerates rapidly and loss of soil by erosion is very considerable". This might equally be written of Africa.

From the forest-botanical point of view the interesting part of Bor's paper is his investigations into the evergreen forest or groves. It is stated that the pagan Khasi regards these groves as the abode of his tribal gods and is forbidden by tribal custom to fell, lop or damage a tree in any way; no flower may be plucked, no fires lit, no cattle grazed. He believes that the deity inhabiting the grove deals out punishment to those who break the tribal custom in this respect. This punishment is usually sudden death. Bor expresses the fear that with the conversion work of the missionaries—he might have added the inevitable arrival of Western civilization, so-called—there will result the loss of tribal veneration for the sacred groves, which will then fall to the evils of the axe, fire and so forth; a regrettable loss of what in his opinion are the remnants of the former forest which spread over much of the region. For Bor's reasons the paper must be consulted, but he shows quite definitely that the climate of the region is a 'forest' one as opposed to a 'grass' one. But surely it should not be beyond the power of a present-day administration to protect by other means what the uncivilized tribesman has for so long safely protected, even when that strict guardianship was due to what the Western peoples regard as purely pagan faith. A study of the depreciated grassland and pine forest areas sufficiently indicate how strict for a long period of time this careful protection has proved; nor should it be beyond the powers of the Indian sylviculturist to extend the areas still occupied by this old indigenous evergreen forest.

Bor's investigations, as he says, are by no means complete; they "represent the gatherings of one rainy season in Shillong on the few occasions when holidays or Sundays afforded a release from the pressure of other work. Great as is the similarity of the floristic of the three areas based on these collections, it is believed that further work will make the similarity even closer". The tallest trees, says the author, in these dark and gloomy evergreen woods, are perhaps 60 ft. tall. The dominant stems have smooth, cylindrical boles and thick crowns which touch. The trunks and branches of the trees on the margins are loaded with lichens, mosses, orchids and other epiphytes. A small-tree layer can at times be distinguished, but it is not at all distinct. The shrubby and herbaceous layers are in places well marked and in others almost non-existent. The soil is covered with mosses and Selaginellas and is deeply stained with humus. Whenever a gap occurs in the canopy owing to the disappearance of a giant, natural regeneration of the dominant species is satisfactory. In his list of species, Bor enumerates 32 canopy trees, 66 small trees, 80 shrubs, 120 herbs, 30 ferns, 20 grasses and sedges, 8 parasites and 44 climbers, which endorses Hooker's remark on the richness of the flora of the region.

The author writes: "It is realized that a far larger number of the groves would have to be examined before reliable details of fidelity and constancy for the species could be obtained, but the object of this paper is not a statistical examination of the groves but an inquiry into the ecological status of the groves based upon the available data".

MANUFACTURE OF OPTICAL GLASS

THE production of optical glass is one of the most difficult as well as one of the most interesting of manufacturing processes. Fraunhofer was the first to realize the necessity for improvement in the manufacture of glass in order to bring it to the necessary degree of homogeneity and to make it free from internal strain, essential requirements for optical glass. It may be said that it has taken more than a hundred and fifty years to bring the art of optical glass manufacture to its present state. Messrs. Chance Bros. have been engaged on the task for nearly a hundred and twenty years and the Chance-Parsons optical glass embodies their experience, together with the newer research work in their laboratories as well as that of the firm owned by the late Sir Charles Parsons, under whom notable advances were made.

It is a cause for satisfaction to record the high quality of the glass produced by a British firm, even under war conditions. In homogeneity and freedom from strain and mechanical defects, Chance-Parsons optical glass can compare favourably with that of any other maker. The publication by Messrs. Chance-Parsons of a new catalogue of optical glass is thus something of an event for the optical designer and manufacturer, as well as for the physicist, as here is found exact data about glass for condensers, ophthalmic lenses, optical instruments and colour filters.

To measure the advance in the last thirty years it may be recalled that on the outbreak of the War of 1914–18 the British maker listed some dozen types of glass with refractive indexes given for four lines of the spectrum from *C* to *G′*. Now there are nearly one hundred types, and the data cover nine lines fairly evenly spaced over the visual spectrum from helium *b* to mercury *h*. Refractometry in the infra-red and the ultra-violet is still in the laboratory stage. When it is recalled that the same state of affairs existed with respect to the measurements in the visual spectrum until Abbe introduced exact measurements and published the data in a manufacturer's catalogue, it is possible to hope that an extension of the data to include the infra-red and ultra-violet will be a possibility before long. This would be a really useful advance as these regions are becoming of increasing importance in industry as well as in pure science. At present, when information is wanted as to the refractive indexes of any glass in the invisible regions, resort must be had to the inaccurate methods of extrapolation, or to the laboratory.

An innovation in the present catalogue is the introduction of a new system of classifying glasses in order of their stability, based on a thermodyne test devised by Chance Bros. which is said to conform well to the results of atmospheric action. Stability is assessed in terms of the period of time during which the glass may reasonably be expected to show no signs of surface tarnish. It is to be hoped that this classification will in time be extended to all the glasses on the list.

A useful feature of the catalogue is the distinguishing, by heavy type, of those glasses which are made regularly and so can be supplied with a minimum of delay. Furthermore, particular care is paid to the maintenance of a stock of certain glasses which are in very general demand, and these are indicated by an asterisk. These can be repeated, in successive melts, within very close limits of optical properties. The designer and manufacturer are therefore advised to use these wherever possible as a change to a new melt can be looked forward to without misgiving, calling for minimum alteration of the data of the system.

There are no fresh glasses recorded in the present catalogue nor any having the extreme properties claimed recently in patent literature, yet the range is wide and covers the normal requirements of the optician; British optical instrument manufacturers have no cause to complain of the lack of variety of material offered them.

Considerable advance is to be noted in the section relating to colour filters, which should be of particular value in laboratory work and in colorimetry, which is becoming of increasing industrial importance.

Glass filters naturally have not so wide a range as those made from coloured gelatin but have certain advantages. They are usually more stable; are more robust and can be more easily handled in the unprepared state; are cheaper when required to be of optical quality since the working of only one parallel flat is involved instead of two; for the same reason they can be made thinner and lighter; and they have a certain adaptability as the transmission can be varied by suitable choice of thickness.

The filters now offered provide a range of colours from infra-red to ultra-violet, as well as neutral and heat absorbing glass. There is also one (didymium) showing sharp absorption in a narrow region in the neighbourhood of the *D* line.

Transmission curves are given for each glass on a separate chart. This supersedes the previous method of plotting densities and is in conformity with other makers' lists. The integrated visible transmission, for a standard lamp and thickness of filter, is also supplied, and a formula given by which the transmission can be calculated for any other thickness. It is believed that there are only two other makers of coloured glass of optical quality in the world, and the English list compares favourably in range with any other.

The makers are to be congratulated on the publication of the new catalogue under present conditions.

H. W. LEE.

MOTION AND FORMATION OF THE PLANETS

TWO papers under the title "Gravitational Theory of Planetary Rotation", and "A New Theory of Planetary Formation", by J. Miller, have just appeared (*J. Brit. Astro. Assoc.*, 52, 5 and 6, June and July 1942). Miller shows that a spherical body or a loose agglomeration of particles, held together by gravitational force or cohesion, which is describing an orbit around a central body, will acquire a rotation in a sense opposite to that of revolution. This rotation is produced by the unequal attractions of the central body or centre of force on the near and remote sides of the smaller body, and the axis of rotation will be perpendicular to the orbital plane. The linear velocity of rotation will vary as the diameter of the body, and will also be a function of the distance between the body and the central force. Owing to the fact that a second order term appears in certain computations, the linear velocity will not be exactly proportional to the diameter, and in addition, internal friction between the different strata has an important effect.

A relation between increments of time in rotation rates and increments in diameters is deduced by Miller, and the theoretical times of rotation for the different planets are computed. Some of these agree well with the actual times of rotation, and, where discrepancies occur, it is suggested that the internal frictions of the planets, for which it is difficult to calculate exact figures, are responsible. It is assumed that the solar system once revolved around the centre of a star cluster, which, in turn, was revolving around the centre of the galaxy, and planetary rotations originated as a result of the difference in the attractions on the near and remote sides of the planets, to which reference has already been made. These rotations have been maintained since they were established, though, as pointed out, there were probably other disturbing factors which modified the original rates to a small extent.

No explanation is given in the first paper of planetary formation, but this problem is attacked in the second paper. The sun alone in the solar system is first dealt with, and it is conceived as originally describing an orbit around a centre of force which may be, as in the previous case, a stellar cluster or the galaxy. Under favourable conditions, such as approach to the periphery of the cluster, the disruptive force of the latter, due to its differential attraction, will at a certain stage overcome the combined forces of the sun's gravitational pull on its external layers and of the cohesion of the particles. A portion of the sun will be removed, and as it makes closer approaches to the cluster, more material will be torn off. Miller suggests that the outer planets were removed first, and as the disrupted sun moved closer to the cluster, it lost more and more material which formed the remaining planets, Pluto being the first to be removed at a great distance and Mercury the last when the sun was nearest to the centre of attraction.

The theory differs from the planetesimal hypothesis of Chamberlin and Moulton in many ways. A cluster, not another star, is held to be responsible for the disruption. In addition, internal forces in the sun, caused by the high temperature, are not considered necessary to assist with the ejection of matter. A tentative explanation of Bode's Law is given, but this is not worked out in detail. The physical condition of the sun at the time of the formation of the planets is left an open question; it may have been in a state somewhat resembling its present condition, or it may have been in a semi-nebulous state. It is assumed that the matter composing the superficial layers did not all possess the same cohesive force, from which it may be inferred that the sun was not entirely nebulous at the time of the disruption, though it may have been very much more extended than it is at present. Miller's theory requires that the outer planets, which were first disrupted, should possess less cohesion than those closer to the sun, so that the cohesive power should increase from Mercury outwards. As, however, great changes have taken place in the planets since their formation, this rule cannot be applied very strictly.

INDIAN FORESTRY RESEARCH*

AS a record of useful economic activities, a report entitled "Forest Research in India and Burma, 1940–41" is an encouraging summary of many-sided investigations under difficult conditions. It deals with the work of the Forest Research Institute at Dehra Dun during the period under review. Naturally the outstanding feature of the year's activities has been the influence of the War. At first the demands made upon the staff of the Institute were connected with supplies, but as its work is primarily research it was for this reason capable of dealing only with comparatively small quantities of materials. It became, therefore, wisely agreed that the Institute could not make its best war contribution by turning itself into a supply unit. It has confined its programme in consequence to research work in connexion with various war problems.

While the activities of the Utilisation Branch of the Research Institute were largely engaged upon war work, rather than normal programmes, those of the Botanical and Sylvicultural Branches were more especially engaged on the normal research and other duties where interruption would lead to waste of previous efforts. In the Utilisation Branch many inquiries were dealt with in connexion with timbers for various war uses. These included bamboos for aircraft work and tent poles; timbers for rifle parts and tool handles; containers for ammunition, for packing army boots, etc. As an example it may be mentioned that cases for army boots were generally made of wood of the chir pine from the Himalayas. The enormous demand created by the War made it necessary to consider other timbers. Semul timber was suggested by the Ordnance Department. Comparative tests of both chir and semul boxes were made and tests showed that the semul boxes were practically as strong as chir boxes and possessed in addition certain advantages. It appeared that the original design of the boxes could be greatly improved so as to produce a much stronger box by very small additions costing not more than a few annas per box. Boxes embodying the improvements suggested were, therefore, made and tested. They proved to be fifteen times stronger than boxes made according to the original design. Among other work of this branch has been the testing of various woods and bamboo for mechanical pulp for newsprint-quality papers. Five species were found suitable for this purpose and inquiries are going on as to supplies and whether they are accessibly situated so as to make the matter an economic proposition.

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* Forest Research in India and Burma, 1940–41. Part 1: The Forest Research Institute. Pp. 161. (Manager of Publications, Delhi, 1941.) Rs. 1.12 or 2*s*. 6*d*.

In the Chemical Branch much attention has been given to chir pine tar, which has been successfully modified to suit requirements of large consumers such as rope works and rubber companies. The cutting off of imported supplies of wood tar has also led to a heavy demand for wood creosote, and other by-products, on the Medical Department. Large-scale production of these has now been arranged and it is computed that the sale of these by-products will bring down the cost of production of heavy tar by about 20–25 per cent. Another problem of interest, but of a much smaller nature, has been the provision of prepared wood dust used by makers of dry electric cells to incorporate with inorganic oxide to give the necessary porosity. Hitherto this substance was imported from Germany, but a highly satisfactory substitute appears to have been obtained by mixtures of spruce and bombax sawdust. It is hoped that in future it will no longer be necessary to import this material.

The Entomological Branch has been occupied with the importation of the bug *Teleonemia scruplosa* from Australia as an aid in the extermination of the pest-plant Lantana. Trials have been successful, but the insect has not so far been released in the field in case, having destroyed lantana, it should attack teak, which belongs to the same natural order of plants. It is not considered likely that such an event would happen, but nevertheless the eventuality is not being overlooked. Problems created by the emergency exploitation of the wood of *Boswellia serrata* for hutting and packing-case timber have been explored, and more especially the best procedure for protection against boring insects of several kinds.

A notable feature stressed in the report is the importance of the results obtained by the Botanical and especially the Sylvicultural Branches in the past. These have made possible the economic exploitation of the immense Indian timber supplies with the least damage to their future continuity.

FORTHCOMING EVENTS

Sunday, August 16

Association of Scientific Workers (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1), at 3 p.m.—Conference on "The Scientific Film and Scientific Film Societies".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Mathematics—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (August 24).

Borough Electrical Engineer and Manager—The Town Clerk, Municipal Offices, Cheltenham (endorsed 'Borough Electrical Engineer and Manager') (August 28).

Graduate Teacher of Mechanical Engineering in the West Hartlepool Technical College—The Chief Education Officer, Education Committee, West Hartlepool (August 28).

Principal of the South Dorset Technical College, Weymouth—The Acting County Education Officer, Education Department, Shire Hall, Colliton Park, Dorchester (August 31).

Regius Professor of Engineering at Edinburgh University—The Private Secretary, Scottish Office, Fieldon House, 10 Great College Street, London, S.W.1 (September 7).

Head of the Chemistry Department—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (September 12).

Harris Chair of Physics, University College, Dundee—The Secretary, The University, St. Andrews (December 31).

Assistant Lecturer in Zoology—The Registrar, University College, Exeter.

Graduate Teacher of Chemistry in the Smethwick Junior Technical School—The Chief Education Officer, Education Offices, 215 High Street, Smethwick 41.

Lecturer in Civil and Mechanical Engineering—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 23, No. 1: Report of the Irish Radium Committee for the Year 1941. Pp. 5. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [277

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 10: The Influence of the Type of Equipment used for the Separation and Treatment of Cream on Churning Time and Loss of Fat in the Buttermilk. By J. Lyons. Pp. 119–129. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s*. [277

Sixty Years of Planning: the Bournville Experiment. Pp. 48. (Birmingham: Bournville Village Trust.) [287

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 146: An Analysis of the Outbreaks of the Australian Plague Locust (*Chortoicetes terminifera* Walk.) during the Seasons 1937–38 and 1938–39. By Dr. K. H. L. Key. Pp. 88. (Melbourne: Government Printer.) [277

National Research Council of Canada: Abstracts of Articles and Patents on the Production of Glycerol by Fermentation. By Muriel E. Whalley. (N.R.C. No. 1070.) Pp. 66. 50 cents. Extraction of Rubber from Plants. By Muriel E. Whalley. (N.R.C. No. 1071.) Pp. 19. 25 cents. (Ottawa: National Research Council of Canada.) [277

National Geographic Society. Solar Eclipse Series, No. 2: National Geographic Society—National Bureau of Standards Solar Eclipse Expedition of 1940 to Brazil. Pp. 98. (Washington, D.C.: National Geographic Society.) [277

Smithsonian Institution: United States National Museum. Bulletin 179: Life Histories of North American Flycatchers, Larks, Swallows and their Allies; Order Passeriformes. By Arthur Cleveland Bent. Pp. xi+555+70 plates. (Washington, D.C.: Government Printing Office.) 1 dollar. [277

Brooklyn Botanic Garden Record. Vol. 31, No. 2: Containing the Thirty-first Annual Report of the Brooklyn Botanic Garden, 1941. Pp. viii+55–182. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [277

Bulletin of the American Museum of Natural History. Vol. 79, Art. 3: Results of the Archbold Expeditions, No. 41: Summary of the 1938–1939 New Guinea Expedition. By Richard Archbold, A. L. Rand and L. J. Brass. Pp. 197–288+35 plates. Vol. 79, Art. 4: Results of the Archbold Expeditions, No. 42: Birds of the 1936–1937 New Guinea Expedition. By A. L. Rand. Pp. 289–366. (New York: American Museum of Natural History.) [277

U.S. Office of Education: Federal Security Agency. Education and National Defense Series, Pamphlet No. 16: How to Read the News. Pp. iv+27. 15 cents. Education and National Defense Series, Pamphlet No. 21: Helping the Foreign-Born Achieve Citizenship; a Teachers' Guide. Pp. vi+36. 20 cents. Bulletin 1941, No. 9: Secondary Education in Austria, 1918–38. By Max Lederer. Pp. vi+41. 10 cents. Pamphlet No. 94: Some Principles of Consumer Education at the Secondary School Level. Pp. v+42. 10 cents. (Washington, D.C.: Government Printing Office.) [277

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FOOD STORAGE AND TRANSPORT

THE problems of storage and transport of food have troubled men ever since they began to crowd into cities and to attempt to live at any density in northern latitudes. A diet of the cereals that made these developments possible is obviously monotonous ; less obviously, but as inevitably, it is inadequate to maintain health. The three chief deficiency diseases that are recorded as causes of deaths—scurvy, beriberi and pellagra—are associated with diets consisting too exclusively of the three great cereals—wheat, rice and maize. In England scurvy was common until the introduction of potatoes and root crops, which supply vitamin C directly to human beings, or feed animals that will provide fresh meat and milk.

War brings back the old problem in an acute form. Armies are transported to places where they cannot get fresh food, and civil communities are cut off from their normal supplies. During the War of 1914–18, in spite of the relatively high standard of nutrition maintained and the recognition of the relation of these diseases to diet, British troops in Mesopotamia suffered from scurvy and beriberi, and small epidemics of scurvy appeared in Britain when potatoes were scarce in 1917. When the diet is uniform and monotonous the effects of any deficiency become cumulative ; hence the frequency of beriberi in prisons and asylums. Soldiers and others who live on fixed rations, if these are not soundly planned, are liable to deficiency diseases ; while civilians, though their food supply may be less well cared for, escape because they get a greater variety of diet and may protect their health by what may appear to be extravagances and indiscretions. The rations of British troops[1] in the Mediterranean in 1915, and even the diets of Armenian refugees at Port Said[2] in 1916, would have seemed luxurious to German civilians in 1917 ; but the soldiers got beriberi and the refugees pellagra, while the Germans suffered from neither.

The more the exigencies of war limit our food supply the more should we aim at maintaining a variety of foodstuffs and insist that these should keep their full nutritive value. We should not depend on supplements of vitamins. The diets given to British soldiers in the Mediterranean area during the 1914–18 period were planned on the basis of knowledge as it had stood a few years before; but they proved deficient. It would be presumptuous to assume that we now know the whole range of our nutritive requirements and that a diet made up artificially, on the basis of knowledge as it stands now, would be complete. We must still depend on natural foodstuffs for our nourishment and use vitamin supplements only as a last resource.

Two vitamins, obviously, need to be considered—A and C ; for the supply of vitamin A is reduced by the loss of imports of butter (33 per cent of the supply in 1938 came from areas now in enemy hands) and that of vitamin C by the restriction of the imports of citrus fruits. We depend mainly on vegetables to make up the lack of these two vitamins. In the early months of the year, when green vegetables are scarce, supplies of both fall below the amounts considered necessary. Preserved vegetables would help us to tide over this period. Soldiers who have to depend on food transported from a distance are liable to go short of vitamin C at all times of the year, and they may get little vitamin A from sources such as butter; preserved vegetables that retain their vitamins are therefore a necessary part of their rations. Apart from these more obvious examples, the supplies of nicotinic acid, riboflavin and animal protein are reduced by the shortage of meat. We should, therefore, aim at conserving these two vitamins and the biological value of proteins in any foods that are preserved.

The conditions of the present War modify the problem; they enhance the importance of transport as compared with storage. Owing to difficulties of shipping, weight and bulk must be kept to a minimum. So far as the supplies of the people of Great Britain are concerned, one solution is to limit imports to foods, such as wheat, that contain little water, and to produce the perishable foods at home. But this does not solve the problem of the soldier abroad, who depends on shipping for the whole of his rations. However, half or more of the weight of most of the perishable foods is made up of water. If this could be removed the tonnage required for their transport would be correspondingly reduced. We need, therefore, a method by which foodstuffs can be dried, without loss of their nutritive properties, rather than preserved in other ways such as canning.

Attempts have been made, from the earliest times, to preserve the perishable foods, more in order to provide variety than to safeguard health; but these attempts were not wholly successful; the products were not even palatable. In England the stored meat became high during the winter; strong spices were needed to mask the taste and prodigious quantities of beer to wash down the spices. The vicious tradition of strong sauces and pickles and the less noxious habit of copious beer drinking had once their justification. During those phases in the history of scurvy in which the relation of the disease to lack of fresh fruits and vegetables has been accepted, efforts have been made to prepare dried vegetables for use as antiscorbutics. During the War of 1914–18 the only vegetables in the rations of the Austrian army were dried by a process in which an influential personage had an interest. They were popularly known as "barbed wire"; the discontent caused by these bad rations contributed much to the collapse of the Austrian army. All attempts at the preservation of fresh vegetables failed for reasons that we now understand. The processes of canning fruits, by which some of the vitamin C is preserved, were developed in order to provide variety; the improvements of the commercial processes, which ensure that very little of the vitamin C is destroyed, have been dictated more by the desire to preserve the flavour than by any thought of nutritive value.

The present need to economize shipping has stimulated new efforts to preserve foods by drying without loss of palatability and nutritive value. The methods have made use of recent discoveries in connexion with the loss of vitamin C in cooking. Until a few years ago, it was thought that the vitamin C in vegetables is destroyed rapidly when these are heated in presence of air, in the same way as it is in simple solutions. It was therefore natural to suppose that the best way of drying vegetables would be to freeze them and then evaporate water under reduced pressure. The product obtained by this method is bulky, and owing to its open structure very susceptible to the water vapour of the atmosphere. It is now realized that the ascorbic acid is more stable when in plant tissues; but that an enzyme present in the cells destroys the ascorbic acid when the tissues are damaged by bruising or by heat. The main lossess in cooking are due to three processes: first, the action of the enzyme during the period that elapses after the heat damages the cells and before it destroys the enzyme itself; second, the extraction of the ascorbic acid by the water in which the vegetable is cooked; and third, and least important, destruction by heat and oxidation, without the assistance of the enzyme, as in simple solutions. Losses in cooking can be reduced to a minimum by heating up the vegetable rapidly to boiling point, in order to give the enzyme little time to act, and by using cooking water repeatedly so that the concentration of ascorbic acid in it approaches that in juices of vegetables. In the same way, the losses in drying are due to the action of the enzyme.

The extent to which modern knowledge has been foreshadowed in the past is remarkable. For not only had the essential role of fresh fruit and vegetables for the prevention of scurvy been demonstrated and forgotten repeatedly up to 1916, but so far back as 1757 Lind wrote that when the Lords of the Admiralty proposed that dried vegetables should be tried as antiscorbutics "it was objected by the very ingenious physician [Dr. Cockburn] that no moisture whatever could replace the natural juices of the plant lost by evaporation and, as he imagined *altered by a fermentation that they underwent in drying*". Change "fermentation" to "enzyme action" and the words of the very ingenious physician might be written to-day.

If vegetables are first scalded rapidly, the enzyme is destroyed and they can then be dried in a current of air, without special precautions save that the temperature should not rise above 80° C. Vegetables dried in this way and later cooked contain as much ascorbic acid as do cooked fresh vegetables. Loss of carotene (which is the precursor of vitamin A) can be avoided. Meat treated by preliminary short cooking loses none of its nicotinic acid and riboflavin. From the point of view of nutritive value the difficulties of drying have been overcome. Yet people will not eat foods, however great their nutritive value, if they are not as palatable and attractive in appearance as those with which they are familiar. Many families in Great Britain have gone short of animal protein this year, although they could get unlimited supplies of skim milk powder. Fortunately, palatability and appearance seem to run parallel with nutritive properties. The preserved vegetables are eaten as readily as fresh, and dehydrated meat will serve one of its most important functions in modern diets—that of providing flavour. As ascorbic acid can be estimated without difficulty, it should be possible to guarantee the general qualities of dried vegetables by insisting that they should contain specified amounts of ascorbic acid. The new method is commonly called dehydration to distinguish it from the old drying processes in which nutritive value was lost.

It is probable that the drying plant in Great Britain, in the immediate future, will be no more than sufficient to meet the needs of troops. It is to be hoped that, at some time in the future, it will be possible to use dried vegetables to add to the civilian supply of vitamins C and A during the early months of the year. The process seems so simple that it should be possible to make an efficient domestic dryer. Storage in air-tight receptacles should not be necessary, as the dried vegetables keep their ascorbic acid for some months when exposed to air.

After the armistice of 1918, the great shortage of shipping and the crippled state of the railway systems of Europe hampered and delayed the relief of the urgent scarcity of food east of the Rhine. When hostilities again cease, the available shipping will again be insufficient, the railway systems more severely damaged and the need for food will be even more serious. The difficulties of transport are recognized as one of the obstacles to the relief of famine. The diets recommended by the Health Organization of the League of Nations[3] for famine relief are made up of dry foods, cereals, milk powder and cod liver oil; they do not provide vitamin C. Dehydrated foods should be most valuable in supplying a more satisfactory diet.

When the urgent demands of famine relief have been met, a new problem will arise if our promises are taken seriously. We have guaranteed that no one in any part of the world shall suffer from want. It should be comparatively easy to ensure that no people go in want of food energy. In peace-time there is no gross shortage of food energy, when crops are normal, in any part of the world. An International Famine Prevention (not Relief) Organization could keep a watch on crops throughout the world and keep a stock of cereals that could be shipped to any area where a bad crop was anticipated. But it is perishable foods which are scarce. The best final solution would be that some of these perishable foods should be produced in countries which are specially suitable, and transported to other parts of the world, while a considerable proportion should be produced where consumed. This local production is both convenient and economical, as one-type agriculture is in the long run unsound. But it involves the reorganization of agriculture and a redistribution of the population of the most congested areas.

This will all take time, and in the interval these perishable foods must be imported from other countries in some form suitable for transport; again, dehydration should lessen the difficulties of the task. The production of the quantities of those foods that will be required will involve an enormous expansion of plant, and this expansion will raise problems of materials and labour, which will have to be apportioned between these and other projects. This process of reconstruction will involve a gigantic co-ordinated scheme, and it will come to nothing if it is not thought out beforehand. No speeches, declarations or charters will, by themselves, make the fruits of the earth fall into the lap of the Indian coolie or even of the peasant of south-eastern Europe.

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[1] Med. Res. Council, Special Report, 167, 248 (1932).

[2] Wilson, W. H., *J. Hyg.*, 20, 1 (1920).

[3] *Bull. Health Org.*, 7, 677 (1938).

MAN'S RELATION TO THE LIVING WORLD

The Discipline of Peace

By K. E. Barlow. Pp. 214. (London: Faber and Faber, Ltd., 1942.) 8*s.* 6*d.* net.

THIS stimulating little volume makes an admirable complement to Lewis Mumford's "Technics and Civilization", which contains indeed the essence of Dr. Barlow's argument. Whereas Mumford is concerned primarily with the effect of the machine on man and how man is to regain control over mechanization, Dr. Barlow's approach is from the biological side, and he is concerned with the effect of man's interference with the balance of Nature. The importance of these ecological considerations, alike for our war effort and for post-war reconstruction, is slowly being realized, and Dr. Barlow's volume should materially assist that process of education.

The main argument of the book is that since man lives by the living balance of Nature—soil, plant and animal woven together in a vast balanced system—it is important that man should ascertain how his own character is related to the rest of life and how his machines link up with it. Only against this background can our essential social problems be understood. Justice and the association of man with his fellows in a commonwealth of peace are only possible when an attempt is made to administer the commonwealth of mankind for the benefit of mankind. If man is to enjoy the fruits of his estate, he must first recognize what is due to the natural world by which he lives, and become the responsible manager and administrator of Nature and no longer the mere exploiter.

It is one of the tragedies of the present situation that just when the ecological argument which Dr. Barlow ably sustains in his chapter on soil erosion is becoming more widely appreciated, the exigencies of total warfare are leading to further exploitation of natural resources and disturbances of the balance of Nature on a scale and in terms of a short-range policy, which it may take the work of generations to repair. On the other hand, as Dr. Barlow points out, the change back from war economy to peace economy fortunately involves an inevitable reorganization of industry which may well give us the opportunity to strike a new balance between industry and agriculture, though it would be rash to assume that the implications of the reactions of food, flood and agriculture are as yet fully or widely grasped. That is an essential preliminary to the development of the adequate organization, and the recognition in a number of recent reports on reconstruction of the importance of a balanced relation between agriculture and industry is at least a hopeful sign.

The value of Dr. Barlow's volume at the present time lies also, however, in his lucid exposition of what is involved in any policy or programme for reconstruction. He brings us face to face with the permanent conditions of politics—the laws of the relation of man to his environment which political philosophy and social planning have tended to ignore. Man's first peace problem is to secure the conditions which will make it possible for him to live at all, and one of the first aims of a wise peace conference would be the restriction of the trade of agricultural peoples to the limits imposed by the balance of Nature, even although this involves a change in the social organization. The idea that agricultural practice must be increasingly modified by the need for protecting soil and vegetation is forced on us not merely by considerations of town planning or location, but also by the primary instinct for survival.

Granted that man must increasingly co-operate with, instead of exploiting, Nature, and that the prospects of peace depend ultimately upon human understanding and effort and sufficient humility and determination to work tolerantly with the processes from which our well-being derives, something approaching a revolution in thought will be required before the great industrial nations will accept not merely the discipline of personal behaviour but also the shrinkage in industrial activity involved in the organization of a new economy in which industry is no longer an orgy of exploitation but a limited and balanced organ in the kingdom of life. Dr. Barlow's exposition of what is involved in regard to international trade between industrial and agricultural communities should bring home to every reader how far we yet are from being able to attempt to lay down the blue prints of a new order which could claim to be durable.

This realistic approach is not Dr. Barlow's only claim upon the attention of the scientific worker. In his argument he links together the ideas of discipline and peace—so often mistakenly regarded as opposed —and brings us to face the imperative necessity for a faith or philosophy for living. Discipline has too long been despised as a military or slave virtue, and the fact that it is one of the fundamental virtues, close to the core of Christianity itself, without which civilization cannot survive, is commonly forgotten or ignored. Even Prof. Mannheim eschews the word in calling for the elaboration of a new and dynamic conception of both freedom and discipline in social reconstruction.

There are healthy signs in the growing recognition that there must be civic duties and responsibilities as a counterpart to freedoms and rights in a new order, that the emphasis must be on service owed to the State rather than on rights conferred. Dr. Barlow's description of discipline in what may be termed the professional or scholarly sense of the word, the self-restraint and conformity which must be accepted by any disciple or recruit in a skilled or learned occupation, cannot but induce the reflection that we have yet much to learn before we acquire the technique and discipline essential to the building of an ordered world, dynamic not static, and free from the strains set up by lack of balance or disequilibria. In Dr. Barlow's view, the higher social and political activities of man are a further elaboration of the processes in Nature in which, as we pass from plant to animal and to man, the characteristic discipline of each is elaborated and interwoven with the disciplines which preceded it, and their understanding is equally relevant to the problem of providing in human society the conditions of peace.

In his attempt to point the way to an adequate philosophy, Dr. Barlow is less successful than in his ecological analysis, but none the less his book is a fine challenge to the fundamental thinking that must precede any real reconstruction. The absence of such a philosophy is largely responsible for unco-ordinated, destructive and unsatisfying energies. If man with his formidable powers wishes to live at peace in the world, it is essential that his knowledge should be an adequate guide for his acts, and nothing but positive articles of faith will be of value to us. Our task is to understand how conflict between man's initiative and that of Nature can arise: on this question of the relation of knowledge and action, Dr. Barlow's point of view is suggestive and to many scientific workers, if not novel, at least unusual. Modern activity is based on science, but pointing out that science, which is merely the elaboration of a faculty which man has always possessed even if in rudimentary form, should not be blamed alone because man interferes with the detail of his surroundings without heeding the archetypal pattern into which that with which he interferes is gathered, Dr. Barlow insists that what is new in the scientific civilization is the complete separation of the manipulative from everything else, including the archetypal organization of Nature. While greatly increasing the scope of the manipulative technique of science and extending the range of man's own physiological performance, this has also released manipulation from the major discipline of Nature.

To strike a balance between these major disciplines of life—that of Nature on one hand and of man and of his manipulations on the other: is one of the major problems to be solved if man is to regain control of the machine which is the immediate social consequence of his use of science. A new conception of machine organization is a first preliminary to a stable world order. The over-riding prerogative of the machine must be replaced by a balance and an integration with the other factors in the biological hierarchy, in which not merely the physical and physiological needs of man but also his cultural, social and spiritual needs are satisfied.

Dr. Barlow does not conceal the difficulties which will be encountered in the practical application of the ideas for which he argues so cogently. The co-ordination of our machines with the other phases of natural and social life, for example, is an urgent aspect of replanning our cities. On the other hand, he makes equally plain the dangers to essential liberties inherent in present attempts to make man's actions fit an industrial system instead of allowing him to recognize his natural relationship and the importance of reconciling the discipline which is necessary to society with the preservation of the qualities of the citizens who come under that discipline.

The book is a courageous attempt to see life steadily and to see it whole, and to envisage the action which must follow as we come to understand the discipline under which we must live. Here is no flinching from consequences but a challenge to both thought and action. The price of liberty in a social system is the display by the management of the community of the powers of combination and order which are characteristic of life. Man's freedom to understand his situation must be absolute, but the primary issue is not how we are to treat materials but how men are to treat each other and the life of the earth which endows them. To realize the full potentialities of an ordered freedom within the delicate structure of life, we must first create within the wide estate of Nature the conditions which that freedom implies and demands. Whether or not we agree with all Dr. Barlow's conclusions, no one can question the sincerity or the dignity of this call to the fundamental and creative thinking on the adventures of ideas out of which alone we can hope to build a social and an industrial order which will serve man's twin desires for order and for growth.

R. BRIGHTMAN.

BIOLOGY OF THE CUCKOO

Cuckoo Problems

By E. C. Stuart Baker. Pp. xvi+207+12 plates. (London: H. F. and G. Witherby, Ltd., 1942.) 25*s.* net.

THIS is the most exhaustive work on the biology of the cuckoo that has yet appeared. The author's qualifications for writing it are unique, for not only has he studied the habits and economy of birds of this family for nearly seventy years, but also he has obtained far and away the most complete collection of cuckoos' eggs, together with the eggs of their fosterers, that has ever been got together, for practically all the known genera, species and races of Europe and Asia are represented, besides some from other countries. Moreover, the work of other investigators is not neglected in discussing the various problems dealt with in this book.

The first part deals with the necessity for cuckoos' eggs being adapted to those of their fosterers. Mr. Baker's evidence clearly shows that the owners of the selected nests often display discrimination, for they may either desert the nest in which the cuckoo's egg has been deposited, or they may eject the egg or in some other way destroy it and so prevent it being hatched. Such discrimination has resulted in the evolution of adaptation between the eggs of the cuckoo and those of their fosterers in size, colour and general appearance. Since individual cuckoos normally keep to the same foster parent, there comes to be a close resemblance between the eggs of the parasite and those of the dupe. Thus, the case would appear to be one of simple Darwinian selection. The evidence for all this is very fully set out, not only for the common cuckoo, but also for other species and varieties of Cuculidæ, and Sir Edward Poulton in a foreword fully endorses Mr. Baker's conclusion. The beautiful coloured plates which are reproduced from Miss Edna Bunyard's original drawings showing the types of eggs of various kinds of cuckoos, together with the eggs of their respective fosterers, add to the value of the treatise.

In the last chapter dealing with adaptation, the author discusses the origin of the parasitism, and points out that the habit of laying eggs without nests was probably primitive in birds, being normal in their reptilian ancestors. Hence the practice of so many cuckoos may be regarded as being partly of the nature of a reversion to a state when birds laid their eggs in various places without making nests.

The next part of the book deals with the question as to how the cuckoo deposits its egg in the fosterer's nest. The author accepts Chance's evidence as proving beyond contention that cuckoos very usually lay their eggs in open nests, as do so many other birds, but without the cuckoo placing its feet and weight upon the other eggs. In other cases, however (as with some cuckoos in India), the eggs may be projected into nests within holes which the cuckoo cannot enter. Further, in addition to these two proved methods, the author thinks that there is a third way whereby eggs are placed in nests in which they can be neither laid nor projected, and he discusses the evidence for the old assertion that the bird may lay its egg on the ground and then carry it in its beak. Without coming to any definite conclusion, Mr. Baker is of opinion that this method is adopted in cases where the bird could not insert its egg in any other way. This probably happens sometimes with the plaintive cuckoos of India and with some other species.

The last part of the book treats of other cuckoo problems such as territories, the ejection of fosterer's eggs and young, numbers of eggs and provision of nests before laying, and the evidence in all these matters is fully given. The author states that with all the species of Cuculus the eggs are laid at intervals of forty-eight hours, once the process has started. The number of eggs is usually from twelve to eighteen. It is very unlikely that the eggs are fertilized in the ovaries, as the author appears to assume, for the observations of Warren and Kilpatrick clearly indicate, as pointed out by Hartman and Hammond, that in the fowl the gametes unite at the anterior end of the oviduct. In the turkey and various other birds (and possibly in most or even in all) the eggs of the entire clutch are fertilized as a result of one treading, so that the spermatozoa must survive for twenty to thirty days within the body of the hen. In gallinaceous birds, however, ovulation takes place spontaneously, whereas for most other birds there is general evidence that the first ovulation does not occur without coition, or in any event without a stimulus from the male, and further, that the process in nearly all birds depends also upon the number of eggs in the nest, since it may be repeated many times if the eggs be removed. One would like to know if similar considerations apply to the cuckoo. The observations indicating that cuckoos are promiscuous suggest that they copulate several times during the short single breeding season. One would like to ascertain if the oviduct normally contains living spermatozoa through the whole period. The existence of suitable nests within the territory may well constitute the main stimulus for repeated ovulation. Assuming this to be so, when the cuckoo lays in the nest of an unsuitable fosterer such as the wren, or outside its territory, it is probably because the bird has already ovulated as a result of an earlier stimulus, and holds in the oviduct an egg that must pass out. The absence of available nests would presumably inhibit ovulation but not the actual laying, once the egg has left the ovary.

The book concludes with valuable appendixes containing data of the weights and measurements of eggs, dates of laying, desertion and rejection of eggs and various other interesting matters. It may profitably be studied in conjunction with Friedmann's book on the cowbirds and Davis's article on the American cuckoos of the sub-family Crotophaginæ, recently published in the *Quarterly Review of Biology*, in which similar problems are discussed. It is to be hoped that a new edition will be provided with an index.

F. H. A. MARSHALL.

Genetics for Medical Students

By E. B. Ford. Pp. iv+162. (London: Methuen and Co., Ltd., 1942.) 7*s.* 6*d.* net.

THE publication of this competently written book which was prepared ostensibly for medical students is particularly opportune. In a straightforward and clear manner the author outlines the principles of particulate inheritance. The medical reader will be pleased to note that examples from man replace bottled Drosophila or wrinkled peas. After an adequate and clever account of Mendelism, which may surprise a pedantic geneticist, of linkage and the genetics of sex, there is a chapter on mutations and the nature of heredity. This chapter is a brilliant essay which will go far to counteract prevalent fallacies regarding the inheritance of environmentally influenced characters.

Other chapters on polymorphism, blending inheritance, gene action and blood groups answer many problems of the medical and sociological worker. The author suggests a useful nomenclature to clear up the muddle apparent in most accounts of the genetics of blood groups.

A chapter is devoted to methods which may be adopted in analysing the inheritance of characters in man. There are useful appendixes containing references for further reading, a list of inherited characters in man, and an account of mitosis and meiosis more than adequate for the comprehension of modern genetics.

This book fills a long-felt want by the medical profession and contains both simple descriptions of the fundamental principles of human genetics and illuminating passages of considerable thought and originality.

F. W. Sansome.

The Statesman's Year-Book

Statistical and Historical Annual of the States of the World for the Year 1942. Edited by Dr. M. Epstein. Seventy-ninth annual publication, revised after Official Returns. Pp. xxxvii+1474. (London: Macmillan and Co., Ltd., 1942.) 30*s.* net.

THE revision of statistical information for many States of the world has been difficult and in some cases impossible, but nevertheless this annual volume contains all the latest figures for the British Commonwealth, the United States and other lands within reach, while for enemy lands, or enemy-occupied lands, figures are at least up to the date of enemy action and even later. The editor has retained the arrangement of States as in pre-war editions except that Estonia, Latvia and Lithuania are now included with Soviet territory. Abyssinia tardily remains within the pages of Italian colonies; Syria remains under French tutelage; but the position of States matters little; the factual information is the valuable side of the book.

It has been found impossible to include the usual tables of world production of various commodities, but two maps, as usual, are provided, one showing naval bases in the Indian and Pacific Oceans and the other the boundary settlement of this year between Ecuador and Peru. Under additions and corrections there have been inserted many facts about Canberra, the federal territory of Australia, and about recent social and economic changes in the authoritarian regime in France. The size of the volume is practically the same as in recent years.

The Philosophy of Edmund Husserl

The Origin and Development of his Phenomenology. By E. Parl Welch. Pp. xxiv+337. (New York: Columbia University Press; London: Oxford University Press, 1941.) 22*s.*

EDMUND HUSSERL died in 1938 at the age of seventy-nine. His writings have had considerable influence on the Continent, but not much in English-speaking countries. He was mainly concerned to give an adequate account of the nature of experience, as that behind which we cannot go and upon which all belief and action are founded. Husserl considered experience to be self-revealing, so that careful attention to what is present to the mind is all that is needed and indeed possible; provided that experience is understood in its full sense, as that which is lived through and directed towards something, not taken partially and incompletely as a collection of 'sense data' after the manner of the Positivists. Like many thinkers, especially German ones, Husserl, having got hold of one good idea, runs it to death by expecting it to do the work of a whole philosophical system. He seems to have thought he was rescuing philosophy from a false psychology, but it is possible that his real merit has been to inspire the Gestalt School of thinkers to help to rescue psychology from a false philosophy. In this matter, however, it is doubtful whether Husserl's attempt at a comprehensive system has done more than the tentative efforts of his teacher Brentano.

The author of this book has tried conscientiously to expound Husserl's thought in clear and intelligible English, and also to compare it with some other types of philosophy. He has supplied an extensive bibliography and some useful criticism of other thinkers, but, for the rest, Husserl remains obscure and only partly intelligible. The fault does not appear to lie with the expositor.

A. D. R.

Electrical Engineering

By W. Tolmé Maccall. Vol. 2. Pp. viii+463 (London: University Tutorial Press, Ltd., 1942.) 15*s.*

THIS book, combined with vol. 1, "is intended to cover the fundamentals of all branches of electrical engineering dealt with in the usual three years day courses". The intention is an ambitious one, and, while the book compares very favourably with others of a like nature, it is not surprising that the result is a superficial treatment of doubtful value to the serious student. It is to be hoped that the average undergraduate is given a deeper insight into the fundamentals of the subject than is provided by the author. The book could have been improved considerably in this respect by the exclusion of those topics which it has not been possible to deal with adequately, of empirical data, constructional details and illustrations, experimental tables, etc., and the real scope increased correspondingly by deeper inquiry into the physical principles underlying the operation of the apparatus and equipment discussed. One of the primary aims in teaching should be to stimulate critical analysis and flexibility of outlook, and the author's treatment of the subject is unlikely to assist materially in this direction. The task attempted is made difficult by the rapid growth of the subject, and in these circumstances it is questionable whether any really useful purpose can now be served by books of this 'comprehensive' type.

DRIED FOODS

AT a joint meeting of the newly formed Nutrition Society and of the Food Group of the Society of Chemical Industry, held in the Great Hall of the British Medical Association on July 25, a series of papers was devoted to giving an account of the results that have recently been achieved in improving the quality of dried foods. The meeting was private, several hundred members being present. In the morning the chair was taken by Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, and in the afternoon by Dr. H. E. Cox, chairman of the Food Group, deputizing for Dr. L. H. Lampitt of Messrs. J. Lyons and Co. Ltd., who was unfortunately prevented from being present.

In introducing the morning session, Sir Edward Appleton told the meeting how the Food Investigation Board of his Department, under the chairmanship of Sir Joseph Barcroft, had realized the tremendous importance which must attach to the utmost economy in transport of foodstuffs, particularly overseas transport, under war conditions, and had been concentrating for some time on dehydration. It has been estimated that in peace-time we imported every year as much as three million tons of water with our foodstuffs.

He thought that history would show that science had made tremendous contributions in the present War and that these contributions had been made largely by anticipating needs. It was quite possible that the work that had now been done on dried foods would be far from the least of these. It had been realized that the nutritional quality of dried foods was of critical importance and the Medical Research Council had collaborated on this aspect at the Dunn Nutritional Laboratory, Cambridge. The work had been organized by Mr. Eric Barnard, director of food investigation, and carried out chiefly at Cambridge under the scientific leadership of Dr. Franklin Kidd, of the Low Temperature Research Station.

In an introductory paper covering all commodities, Dr. Franklin Kidd pointed out that fundamentally no new discoveries had been made but that, nevertheless, by bringing together what was already known in other branches of the food industry and applying the results to dehydration, it could now be said, in general, that the nutritive quality and palatability of dried foods such as meat, fish, milk, eggs and vegetables would be equal to that of those preserved by the established processes of canning and refrigeration. The main principles which had in general to be observed were to destroy the enzymes by a short heat treatment before drying; to maintain a low water content in the dried product during storage and distribution, which can only be done by shielding it from contact with air; to exclude oxygen or retard oxidative changes by the use of antioxidants and avoidance of contamination with traces of metal; to avoid temperatures during drying above a certain limit which can easily be determined for any product, but nevertheless to dry as quickly as possible; to avoid temperatures during drying at which bacteria will flourish; and, lastly, to select the best material as regards flavour, appearance and nutritive value and to treat it with scrupulous cleanliness during the manufacturing operations. We could not hope for good dried foods if drying were used as a means of disposing of fresh food which had deteriorated too far for distribution in the fresh condition.

As an illustration of the economy in space and weight Dr. Kidd stated that the requirement for a full normal dietary consisting of flour, biscuits, cereals, potatoes, vegetables, pulses, meats, soups, fats, sugar, eggs, fish and milk, in the requisite proportions and including packaging, would reduce to a quarter of its weight and volume.

Dr. E. C. Bate-Smith, Miss E. M. Cruickshank and Dr. J. G. Sharp described fully the process for the drying of meat in the form of a mince which, for storage and distribution, is compressed into blocks and packed in air-tight cans. It had been found that the digestibility of this meat was unimpaired and that when the drying was carried out between the temperatures specified (60° to 80° C.) there was little or no loss of vitamin B_1 during drying, nor was there any loss of nicotinic acid or riboflavin. Vitamin B_1 is also retained during storage, but the retention of nicotinic acid and riboflavin has not yet been investigated. The fat content of the dried meat was 30–45 per cent on a dry weight basis.

As regards egg it had been found that little denaturation and coagulation of the protein occurred in spray-drying if the temperature of drying, as measured by the outlet air temperature, did not exceed 70°. No loss of vitamins A and D was observed during the drying. There was a loss of 30 per cent of the vitamin B_1.

What was particularly aimed at both with regard to meat and egg was the full retention of the characteristic flavour, odour, colour and appearance of the fresh food. Quality grading was therefore being carried out by a system of tasting panels which have proved unexpectedly simple in operation and capable of repeating judgments with consistency and accuracy. Surveys had also been carried out to ascertain the sensitivity of the average consumer to unit differences on panel scoring and, for immediate purposes, the level of what may be described as public acceptance has been ascertained. If dried meat and dried egg are protected from the access of air and the uptake of water, they can be stored for long periods without loss of quality.

Dr. G. A. Reay of the Torry Research Station described the roller-drying of minced fillets of raw cod, haddock and whiting in about a quarter of a minute to a water content of 8 per cent. A better product was produced by mincing pre-cooked fish and drying on trays between temperature limits which have been determined. With both fish and meat it is preferable to mince after cooking, that is, following the natural shrinkage which occurs after coagulation has taken place.

Dr. R. J. L. Allen, Dr. J. Barker and Dr. L. W. Mapson described in detail the process of drying cabbage, carrot and potato. Each of these vegetables must be given a heat treatment ('scalding') before being dried and, for the protection of the ascorbic acid from oxidation, the addition of a small quantity of sulphite to the scalding liquor is very beneficial. The reconstituted and cooked dried cabbage and potato should contain at least 35 per cent of the ascorbic acid of the raw vegetable, which is as much as, or more than, is retained when fresh vegestables are cooked. There is practically no loss of carotene during scalding, drying or reconstitution and cooking.

While storage of the dried product in air, but at low water content, is possible for reasonable periods with cabbage and potato, carrot should always be stored in an atmosphere free of oxygen owing to the destruction of carotene by the oxygen.

In winding up the sessions, Sir Joseph Barcroft spoke briefly of the possible effect of dehydrated foods on the trend of national life and policy. It was clear, he thought, that dehydration plant would have to be situated where the food was produced and that we must realize that, with the possible exceptions of vegetables and milk, the dried foods we obtained would, for the most part, be dried overseas. If dried foods had a future it would obviously have profound reactions on the organization of transport and distribution. It was well worth facing this problem now because it would be much more easily dealt with when industries largely wrecked could be reconstituted on new lines than when normal industries would have to be remodelled at considerable loss. In particular, he wanted British agriculture to take advantage of dehydration as a means of getting the maximum production in its natural season. If British agriculture seized its opportunity, he believed the producer of good food would benefit, although the producer of inferior products might rightly regard dehydration as something of a menace.

The quality of dried foods prepared by the methods now being employed was not only high but it was ascertainedly so by assay for palatability, vitamin content, etc., and hence could be guaranteed. This he considered most important from the point of view of efforts to raise the nutritional status of the population as a whole. It was already clear that the price of dried foods would not exceed that of fresh foods and might be less owing to economies in cost of distribution and saving of wastage.

While it was impossible in so large a meeting for discussion to go into any detail, several interesting points were raised. Mr. Nevill Wright and several other speakers stressed the need of urgency and asked for information as to what steps were being taken to push forward with production of dried meat and vegetables. The question was raised as to what were the most suitable types of plant for drying different foods and, in particular, stress was laid on the importance of the efficiency of drying in terms of fuel consumption.

In reply to these points Dr. Kidd and Dr. Bate-Smith stated that stress had intentionally been laid on the importance of the pre- and post-drying treatment of the products and of the temperature limits during drying rather than on the exact specifications of the plant to be used. It was felt, in general, that while some adaptations might be necessary, the drying of meat and vegetables would not necessarily call for completely new types of plant design. In terms of the value of the material the cost of drying was negligible.

Dr. Colgate wanted to know whether it was possible to dry eggs without losing their beating quality, which contributed much to the value of the egg in the baking trade. He had not found even the best spray-dried egg equal to frozen egg pulp. Dr. Bate-Smith said that even egg dried out in a vacuum in a frozen condition had lost its aerating power to about the same extent as the spray-dried egg powder. However, this loss of beating quality could easily be overcome by the simple device of beating at an elevated temperature, for example, 40°. Even really poor spray-dried egg powder would give good aeration if the temperature of beating was raised to 50° or 55°.

Squadron Leader Macrae described experiences in the Royal Air Force. From every point of view these new dried foods were what was wanted. The men liked them and trials had shown that they got more vitamin C from dried cabbage than from fresh. This was due to the fact that the cabbage was dried in such a way as to preserve vitamin C while at the same time destroying enzymes which caused the loss of vitamin C by oxidation during cooking. The foods were easy to prepare and transport and they offered variety.

Mr. Charley and other speakers stressed the importance of easily prepared foods as a factor in family life, while others directed attention to their advantage in communal and emergency feeding. Mr. McLellan wanted more information broadcast as to simple methods for home-drying as an additional means of saving garden and allotment produce for the winter.

During the midday break a buffet lunch was served, and cooked dried foods manufactured by the improved processes described were sampled. Those present thus had an opportunity of confirming the claims made as regards their palatability.

DIGESTIBILITY OF HIGH-EXTRACTION WHEATMEALS

By T. MORAN and J. PACE

THE digestibility, in terms of energy, by human subjects of high-extraction meals (80–100 per cent extraction) is less than that of flour of 70 per cent or lower extraction. Recent work illustrating this is that of Macrae *et al.*[1], who compared 73 per cent flour with wholemeal (100 per cent), and Krebs and Mellanby[2], who compared 75 per cent flour with a sample of National wheatmeal (85 per cent). Unfortunately, there are no modern data on digestibility for meals between 85 per cent and 100 per cent. Older data exist[3], and it is usually the practice to make the rate of extraction the basis for the comparison of the results of different investigators. In the accompanying figure, these data are plotted in this manner and the wide variation in the results is immediately apparent. In this article we wish to emphasize that in digestibility experiments or calculations on wheatmeals the practice of making the rate of extraction the basis of comparison is fundamentally unsound and may give rise to misleading results and deductions even though the experimental technique of the test meals, etc., is completely satisfactory. At a given extraction the digestibility must depend also on the composition of the wheat grist, the conditioning of the wheat and the method of milling.

The wheat grain consists of endosperm, germ, seed coat (testa, hyaline and aleurone layers) and the shell or pericarp. The layers of the seed coat and pericarp together, with a varying amount of endosperm, constitute the bran; without the endosperm they can be regarded as 'pure bran'.

There seems little doubt, especially in view of the work of Macrae *et al.*[1] on wholemeal, that decrease in digestibility in passing from white flour to high-extraction meals is due to the presence of bran or bran layers rich in indigestible fibrous material. The pericarp or beeswing* includes the layers which contain the most fibre—two determinations gave figures of 21 and 23 per cent against 14 per cent for pure bran (see below)—and it is the presence of this fraction, either alone or in bran, which is mainly responsible for the lower digestibility of high-extraction meals. Our experience with National wheatmeal shows that the bulk of the contained bran particles are substantially full bran including the aleurone layer.

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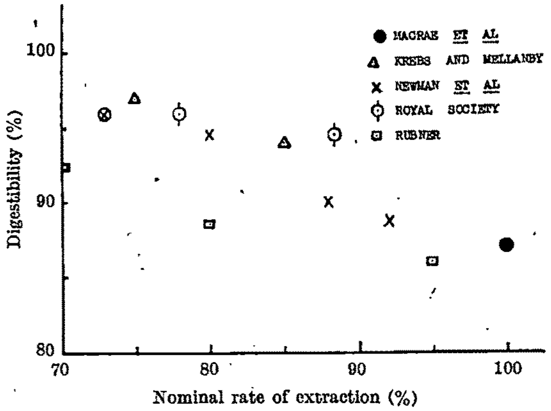
* Beeswing is a general term used by millers and may comprise the whole or part of the pericarp. The actual composition depends on the condition of the wheat and the point of separation in the mill flow; examination of one particular sample from the purifiers showed that it contained all four layers of the pericarp although the amounts of the two inner layers seemed to be slightly less in proportion.



Fibre content is a sensitive index of the amount of indigestible materials in the bran or its separate layers. The size of bran particle has little or no effect[1]. The white flour basis itself has a small fibre content which is difficult to determine accurately but is in the range 0–0·2 per cent; much of this fibre will be from the cell walls in the endosperm. As we move beyond 73 per cent extraction the increase in fibre content is due mainly to bran or its components.

On the basis that the fall in digestibility is proportional to the fibre content it is possible to calculate theoretical digestibility figures for wheatmeals of different fibre contents. The wholemeal used by Macrae *et al.* had a fibre content (reckoned on a 15 per cent moisture basis) of 1·80 per cent and a digestibility of 87 per cent. The 73 per cent white flour used had a fibre of 0·15 per cent and a digestibility of 96 per cent. On the assumption given above it follows that each increase of 0·2 in fibre content (above 0·15) leads to a decrease in digestibility of about 1·1 per cent. Figures calculated on this basis are shown in Table 1.

TABLE 1.

Fibre content	0·35	0·55	0·75	0·95	1·15	1·35	1·55	1·75	1·95	2·15
Digestibility%	95	93·9	92·8	91·7	90·6	89·5	88·5	87·4	86·3	85·2

The only experimental figure available for checking this is that of Krebs and Mellanby[2], who found a digestibility of 94 per cent for an 85 per cent extraction meal which had a fibre content of 0·45. From Table 1 a meal with this fibre content has a calculated digestibility of 94·4.

It is also possible, taking average figures for the composition of the wheat grain—endosperm and germ 86–87 per cent; pure bran 13–14 per cent—to calculate a figure for the digestibility of pure bran. The figure obtained depends on the value taken for the digestibility of pure endosperm. It is most probable that this is in the limits 97–99 per cent. Taking these limiting figures, the digestibility of pure bran works out at 23 per cent and 11 per cent respectively. The fact that the digestibility of the crude fibre alone in wheatmeal bread is of the same order[1] suggests that the particles of bran pass through the gut substantially unchanged except that the attached endosperm and possibly the aleurone layer are digested. At the same time the vitamin B_1 contained in the bran (including that in the pericarp and testa) must presumably be available since, *in vitro*, it is extracted by dilute acid.

Commercially, bran consists of pure bran plus endosperm, and the digestibility of any commercial sample will depend on the endosperm content.

It is of interest to illustrate the points discussed above by two examples.

Example 1

Typical relative proportions of the various milling fractions and the fibre contents of these fractions have been published[4] (cf. also Table 2). From these data we can compound wheatmeals corresponding to different nominal rates of extraction as follows:

% *Extraction*
$80\% = 73(a) + 5(e) + 2(d)$
$85\% = 73(a) + 5(e) + 2(d) + 5(c)$
$90\% = 73(a) + 5(e) + 2(d) + 6(c) + 4(b)$
$95\% = 73(a) + 5(e) + 2(d) + 6(c) + 9(b)$
$99\% = 73(a) + 5(e) + 2(d) + 6(c) + 13(b)$

We can calculate the corresponding fibre contents and hence the calculated digestibilities. These data are brought together in Table 2.

TABLE 2.

Milling fraction	% of whole wheat	Fibre %	Rate of extraction %	Calculated Fibre %	Calculated Digestibility
Wheat	100	1·8			
(*a*) Flour	73	0·2	80	0·55	93·9
(*b*) Bran	13	8·0	85	0·90	92·0
(*c*) Fine bran	6	7·0	90	1·30	89·7
(*d*) Purifier tails	2	6·1	95	1·65	87·8
(*e*) Reduction roll tails and mill finish	5	3·6	99	1·80	87·0

Example 2.

Mr. A. G. Simpson has prepared a series of straight-milled high-extraction flours on the experimental milling plant at St. Albans. The grist contained 70 per cent No. 1 Manitoba and 30 per cent English and was milled at approximately 14 per cent moisture giving flours of approximately 13·5 per cent moisture content. The fibre contents of the wheat mixture and the flours were determined and these are shown together with the calculated digestibilities in Table 3.

TABLE 3

Flour or meal (% extraction on a clean wheat basis)	%Fibre (on a 15% moisture basis)	Parts of pure bran	%Digestibility (calculated)
75	Trace	—	97·0+
85	0·55	3·9	93·9
90	1·0	7·1	91·5
95	1·5	10·7	88·7
100	1·95	13·9	86·3

Samples of bran from three varieties of wheat all freed from endosperm by treatment with dilute lactic acid gave fibre contents ranging from 12·9 to 14·2 per cent (on a 15 per cent moisture basis). Similarly, for a wheat mixture of fibre 1·95 per cent (as in Table 3) and assuming it contains 13–14 per cent of pure (clean) bran, calculation gives the fibre content of the pure bran as 14·4 per cent. On the basis of an average fibre of 14 per cent, column 3 in Table 3 gives the equivalent parts of 'pure' bran in each meal.

An average composition of commercial bran (pure bran and endosperm) from wheat conditioned for the milling of white flour is given below together with an analysis calculated for pure bran. This can only be a proximate analysis because the endosperm attached to commercial bran is richer in oil, protein and ash than the bulk of the endosperm. Incidentally, it would appear that the amount of endosperm attached to the commercial bran was approximately 40 per cent; with the drier milling of National wheatmeal the amount of attached endosperm will be much less and figures for the fibre content of the bran may now reach 11·5 per cent, indicating about 18 per cent of endosperm.

TABLE 4

	Commercial bran%	Pure bran%
Moisture	12·5	12·5
Oil	4·7	8·3
N × 5·7	15·0	16·8
Ash	4·7	8·3
Fibre	7·9	14·0
Non-N material	55·2	40·0

Comparison of Tables 2 and 3 illustrates clearly the fact that meals of nominally the same extraction may have quite different fibre contents and hence different digestibilities. The same fact has emerged even more clearly in a survey of National wheatmeal[5].

Apart from the method of milling, the actual fibre content of the wheat mixture used must also be a factor. For individual wheats this may vary[4] from 1·7 to 2·9, with an average for a present-day grist of about 2 per cent.

With increasing extraction the digestibility of each extraction increment will depend upon the corresponding increase in fibre content. As a matter of interest, for the meals in Table 3 the digestibilities of the fractions 85–90 per cent, 90–95 per cent and 95–100 per cent are 50, 40 and 40 per cent respectively.

All the experimental fibre values quoted in this paper were determined by Mr. R. H. Carter by a modification of the official method which he has developed for wheatmeals; each value can be reproduced to within 0·05. We are also indebted to Squadron Leader T. F. Macrae for allowing us to see the typescript of the paper by him and his collaborators now in the press of the *Journal of Hygiene*, and to Dr. C. R. Jones for much helpful criticism.

[1] Macrae, T. F., Bacon, J. S. D., Hutchinson, J. C. D., and McDougall, I., *Chem. and Ind.*, **60**, No. 40, 723 (1941).

[2] Krebs, H. A., and Mellanby, K., *Lancet*, p. 3 (March 14, 1942).

[3] Newman, L. F., Robinson, G. W., Halnan, E. T., and Neville, H. A. D., *J. Hyg., Camb.*, **12**, 119 (1912). Rubner, M., quoted by Lusk, "Science of Nutrition" (Saunders & Co.). Royal Society Food (War) Committee, 1918.

[4] Booth, R. G., Carter, R. H., Jones, C. R., and Moran, T., *Chem. and Ind.*, **60**, No. 52, 903 (1941).

[5] Staff of Research Association of British Flour-Millers, NATURE, **149**, 460 (1942).

RADIATION FROM THE SUN

By DR. C. E. P. BROOKS

ALL weather, and all life, on the earth are derived ultimately from the sun, and knowledge of the radiation emitted from the sun may be regarded as one of the fundamental sciences. Most of our knowledge of this important subject has resulted from the work and enthusiasm of one man, Dr. C. G. Abbot, of the Astrophysical Observatory of the Smithsonian Institution, who has carried on the work for a generation in the face of many difficulties and much discouragement. The problem is indeed a difficult one, for between the sun and the earth is interposed the atmosphere, and the radiation which reaches the surface is weakened by absorption and scattering. Water vapour, dust, and to a less extent ozone are the worst enemies, and a large part of vol. 6 of the Annals of the Astrophysical Observatory is occupied in describing the continuous attempts to overcome them during the years 1931–1940*. What might have been an even less surmountable enemy, the financial one, has been vanquished mainly with the help of Mr. John A. Roebling.

The difficulties of observation are lessened by making observations at as high a level as possible, to diminish the thickness of the atmosphere traversed by the sun's rays, and in a dry climate to minimize the loss of observations by cloud and also the weakening of the radiation by water vapour. Further, since in spite of all precautions the effect of varying weather conditions cannot be entirely eliminated, several stations must be used distributed as widely as possible in both hemispheres. For the purposes of supply the stations must also be reasonably accessible. Dr. Abbot has sent out many expeditions to test promising localities, but in the present volume the observations from only three are utilized: Montezuma, at a height of 8,895 ft. in Chile, which is the best station; Table Mountain, California (7,500 ft.) and Mount St. Katherine, Egypt (8,500 ft.). Observations were also made for a number of years at Mount Harqua Hala in Arizona, but have not yet been worked up owing to instrumental difficulties, and at Mount Brukkaros in south-west Africa, which though almost cloudless, proved to be too dusty.

The object of the observations is to determine not only the average amount of solar radiation received at the limits of the earth's atmosphere, the so-called 'solar constant', but also its variations from day to day. Since these amount to little more than 1 per cent on either side of the mean (which is still set at 1·94 cal./cm.²/min.) great precision is required both in observation and reduction. Precision in observation is obtained by the refinement of instruments. Direct measurements are made with Abbot's silver-disk pyrheliometer which serves as a permanent standard, and a modified form of Ångström's electrical pyrheliometer to give accuracy and speed in the daily observations. The loss by scattering is given by the pyranometer, which measures the brightness of the sky near the sun and hence the haziness of the air. These instruments give the total radiation falling on them, but since the radiation of different wave-lengths is differently weakened in its passage through the atmosphere, it is also necessary to obtain, with the bolometer, records of the whole

*Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. 6. By C. G. Abbot, L. B. Aldwich and W. H. Hoover. (Publication No. 3650.) Pp. viii+207+7 plates. (Washington, D.C.: Smithsonian Institution, 1942.)

spectrum from infra-red to ultra-violet. These nstruments are described and illustrated in Chapter X, which then goes on to a detailed account of the technique of reduction. The principle is very simple; the higher the sun the less the thickness of the atmosphere traversed and the greater the radiation. Hence, if the state of the atmosphere remains unchanged, a series of observations at different hours, preferably in the morning, can be extrapolated to give the radiation at zero air-mass, that is, the 'solar constant'. In the full or 'long' method computations have to be carried out for about forty different waveengths, and even with the help of a special slide-rule they are laborious, but Dr. Abbot has been able to devise short cuts without appreciable loss of accuracy. The derivation of the 'short' method is described in detail but cannot be summarized here.

Dr. Abbot and his colleagues are continually improving their methods, and in order to maintain a homogeneous series of data, it was necessary to re-compute some of the earlier observations. This has now been done, and no less than seventy-eight pages of the report are occupied with the determinations for nearly every day from August 29, 1923, to September 29, 1939. The result is a series of "preferred" values of the solar constant, but even these are not always quite final. Some of the values show improbably large jumps from day to day, and these were checked by examination of the variations of the short-wave spectrum alone. If these gave more reasonable variations, the "preferred" values were adjusted accordingly, as a series of "improved preferred" values. Some of the resulting changes are relatively large, as much as 1 per cent, and this must to some extent impair confidence in the accuracy of the individual daily values. Dr. Abbot indeed admits as much. From a comparison of the results at three stations, he estimates the probable accidental error of a single daily value as only 0·16 per cent, but he expresses the view that only means of ten days or longer can be regarded as really reliable. Ten-day and monthly means are given from August 1920 to September 1939.

The last part of the volume is concerned with the periodogram analysis of these data. The method used is not described in detail but was apparently graphical; short periodicities were "disclosed" by inspection and removed, disclosing longer periodicities and so on. The method is dangerous, giving rather free play to preconceived ideas of the lengths to be expected, and since all those found are integral parts of 273 months, a check by rigid Fourier analysis would have been both simple and desirable. Dr. Abbot's objection to this is that none of the periodicities is of sine form. He gives an illustration of the determination of three periodicities, and remarks, "We think readers may not be too favourably impressed by the comparison of the 34-month periodicity". He is quite correct in the case of one reader at least; practically the whole of the amplitude found results from the enormous range of the first of the six waves shown. His justification is that the reconstructed curve agrees closely with the original; this claim would be legitimate if all the fourteen waves were of sine form, but is doubtfully so with the complicated forms shown, each of which could be expressed as the result of several sub-waves. The lengths determined range from 8·3 to 273 months; recurrences at intervals of twenty-seven days associated with the sun's mean rotation period are also illustrated and there is a tantalizing reference to the temporary existence of shorter periods measured in days. No relation is found between solar radiation and sunspot numbers.

The great future importance of the study of variations in the solar constant lies in its probable application to weather forecasting. Periodicity is the most obvious method of this application, for if the solar variations are truly periodic they should be reflected, in favourable circumstances, in periodicity of weather. From the point of view of the Astrophysical Observatory, however, this is only a by-product. Dr. Abbot casually mentions that he verified the lengths of the solar periodicities of 8–68 months in meteorological data for a hundred years for three stations (with due allowance for seasonal changes) and he claims two-thirds success for long-period rainfall forecasts, but until the relations between solar and terrestrial phenomena are more fully understood forecasts are probably premature. His great service still lies in the record itself rather than in its applications.

OBITUARIES

Prof. W. H. Young, F.R.S.

William Henry Young, who died in Lausanne on July 7 when nearly eighty, was one of the mathematicians who had contributed most to the revival of English mathematics during the last fifty years.

Young was born in London on October 20, 1863; his family had worked in the City for some generations. His first education was at the City of London School: the headmaster, Abbott, had been a schoolfellow of his father. He went up to Cambridge, at Peterhouse, in 1881, was fourth Wrangler in 1884, and a fellow of his College from 1886 until 1892; in 1939 he was made an honorary fellow. In his early graduate years he did a great deal of teaching, both as a private coach (as was usual with Cambridge mathematicians then) and more officially as a lecturer at Girton. In 1896 he married Grace Chisholm, who had been one of his pupils and was also a fine mathematician. He was the first Hardinge professor of mathematics in Calcutta from 1913 until 1916, professor of the philosophy and history of mathematics in Liverpool from 1913 until 1919, and professor of pure mathematics in Aberystwyth from 1919 until 1923; but the first two of these chairs were rather 'occasional' appointments, and it is something of a scandal that he should never have occupied a regular position really worthy of a mathematician of his rank.

Young became a fellow of the Royal Society in 1907, and was Sylvester Medallist in 1928; was de Morgan Medallist of the London Mathematical Society in 1917, and president from 1922 until 1924; and president of that rather unhappy body, the International Union of Mathematicians, from 1929 until 1936. He leaves his wife and five children, two of whom are also well-known mathematicians.

Young wrote three books (two in collaboration with his wife) and about two hundred papers, all crowded into a little more than twenty years of his life; he was over forty when his first important papers were published. He belonged to the generation of mathematicians which includes Burnside, A. C. Dixon, Forsyth, Hobson, Love, and MacMahon, and was fully the equal of any of them in originality and power; but all of them had established their reputations before he began, and this late start was a serious impediment in the way of his recognition. This was also delayed by a certain conservative hostility to the subjects which he represented, and which scarcely anyone in England understood.

'Complex' function-theory had been introduced to Cambridge a little before (in a rather ill-digested form) by Forsyth, but the 'real' theory was still practically unknown. Hobson and Young were the first true English 'analysts', and "The Theory of Sets of Points", published by the Youngs in 1906, the first real English book on analysis. This is a first-rate book both in substance and in presentation, and it is most regrettable that it should never have been rewritten, in the light of later advances, and reprinted. But all Young's books were comparatively unsuccessful in England. His Cambridge Tract, "The Fundamental Theorems of the Differential Calculus" (1910), though much of its content is now 'classical' and is reproduced in the standard French courses of analysis, never went into a second edition; and the joint "First Book of Geometry", a most interesting and original 'book for children', written in 1905, was 'a complete flop' at home, though it has been translated into four foreign languages.

The theory of functions of a real variable has been completely rewritten since 1900. The remaking began with Borel's famous monograph "Leçons sur la théorie des fonctions", published in 1898. Among those who have remade it Lebesgue, by general consent, stands first; but there is no one else who has contributed more than Young. Young's first work was independent of Lebesgue; he had found definitions of measure and integration different in form from, and in some ways more natural than, Lebesgue's, but equivalent in essentials. He was anticipated by some two years, and the disappointment was a blow; but he recognized the anticipation magnanimously—"the Lebesgue integral" is his own phrase—and set himself whole-heartedly to work at the fuller development of the theory: he was the first, for example, to find a really satisfactory synthesis of the work of Stieltjes and Lebesgue. But his interests were not at all confined to the theory of integration; there is scarcely a chapter of real function-theory on which he has not left his mark. Thus he rewrote a large chapter of the differential calculus, and the theory of Fourier series, and other orthogonal developments, are full of striking theorems discovered by Young.

G. H. HARDY.

Sir Alfred William Flux, C.B.

ALFRED WILLIAM FLUX, who died recently in Denmark, aged seventy-five, was successively mathematician, economist and statistician. Successively, because after being classed as one of the Jubilee Senior Wranglers in 1887, he came under the influence of Alfred Marshall (who had succeeded to the chair of political economy at Cambridge in 1885), was one of the foundation members of the Economic Society (1890), and from 1893 until 1908 was a teacher of economics, first at Manchester and then at McGill University, Montreal.

Flux's main interest was not in the development of the mathematical theory of economics, but in its practical applications to commerce from the statistical point of view. He had been elected a fellow of the Statistical Society in 1893. Though he joined the Econometric Society in 1934, he appears never to have used mathematics in his writings, except in his "Economic Principles" (1904), where, following Marshall, he gave them a subsidiary position. Indeed, he publicly deprecated mathematical tools except as a personal background to verbal analysis. In 1908 he returned to England and was attached to the Board of Trade until his retirement in 1932. During this period he was a very active participant in the work of the Royal Statistical Society, as member of council from 1908, honorary foreign secretary from 1925, and president during 1928–30. Soon after 1932 he made his home in Denmark, Lady Flux's native country, and during part of each year worked at the League of Nations in Geneva. The outbreak of war found him in Denmark.

Flux is best known because of his work on the British Censuses of Production. The first Census (1907) was already organized when he joined the Board of Trade, but he became director in 1911 and wrote the Final Report. He was responsible for the Censuses of 1911 and 1924 and for the initiation of that of 1930. Apart from the normal reports on production, he made three important developments. First he built up estimates of the total national income from the side of production, and contrasted and compared the results with earlier estimates based on the aggregate of individual incomes (Giffen's method); this analysis is of far-reaching importance (*J. Roy. Stat. Soc.*, 1913 and 1929). Secondly, he initiated an index of production, for which the Census provided the weights attached to the different quantity series (*J. Roy. Stat. Soc.*, 1927). Thirdly, he reconstituted Giffen's index of wholesale prices, again using the Census for weighting (*J. Roy. Stat. Soc.*, 1921). These results are now well known as the Board of Trade's Index-numbers of Production and of Wholesale Prices, though from time to time details have been modified.

The Board of Trade and its offshoot the Ministry of Labour have frequently been recruited from the ranks of trained economists who have brought wider views than are commonly taken by those without outside experience. This procedure has been abundantly justified by the importance and originality of the work which has here been too briefly summarized.

A. L. BOWLEY.

Dr. F. Dawtrey Drewitt

DR. FREDERIC GEORGE DAWTREY DREWITT, the biographer of Jenner and historian of the Chelsea Physic Garden, died at his home in Kensington after a long illness on July 29 at the age of ninety-four. He was educated at Winchester and Christ Church, Oxford, where he gained a second class in the School of Natural Science and received his medical training at St. George's Hospital. He qualified in 1876, and after being physician to the Victoria Hospital for Children during 1881–97 and at the West London Hospital during 1882–1902 he gave up medical practice for more congenial pursuits.

In 1903 Drewitt became a member of the British Ornithologists' Union, and afterwards served on the councils of the Zoological Society, the National Trust for Places of Interest or Beauty and the Society for the Promotion of Nature Reserves. He was best known, however, for his connexion with the Chelsea Physic Garden, on the board of management of which he had represented the Royal College of Physicians since 1921, and he was vice-chairman from 1929 until a few months before his death.

Drewitt's work entitled "The Romance of the Apothecaries Garden at Chelsea", which first appeared in 1922 and reached its third edition in 1928, contains a delightful account of the history of the Garden, including mention of the distinguished men connected with it, such as Sir Hans Sloane, Linnæus and Sir Joseph Banks, its most remarkable trees and other plants, and the present botanical research which is being carried out there. His further interest in botany is shown by a little book on the Latin names of common flowers, published in 1927. His "Life of Edward Jenner, Naturalist and Discoverer of Vaccination", of which the second edition was published in 1933, contains besides the description of the introduction of, and opposition to, vaccination, a lively account of Jenner's early life as a country practitioner and his observations on natural history. In 1931 Drewitt published for the first time "The Note-Book of Edward Jenner in the Possession of the Royal College of Physicians of London, with an Introduction on Jenner's Work as a Naturalist", in which he dealt with Jenner's friendship with John Hunter, Dean Buckland and Sir Humphry Davy. In addition to these works on natural history, Drewitt was the author of "Bombay in the Days of George IV: a Memoir of Chief Justice Sir Edward West", published in 1907.

There is no better example of the truth of Buffon's well-known aphorism than that given by Drewitt, whose polished and kindly nature was reflected in his style. His versatility was shown by his being an accomplished artist and twice exhibiting at the Royal Academy. He had many friends not only in the medical profession but also among laymen, the most notable of whom was Ruskin. He married in 1887 but left no issue.

J. D. ROLLESTON.

WE regret to announce the following deaths:

Dr. Arnold Berliner, founder and formerly editor of *Die Naturwissenschaften*.

Mr. D. B. Mair, formerly assistant Civil Service Commissioner and a distinguished mathematician, on July 21, aged seventy-four.

Sir Allen Mawer, F.B.A., provost of University College, London, an authority on English place-names, on July 22, aged sixty-three.

Prof. John H. Salter, formerly professor of botany in the University College of Wales, Aberystwyth, known also for his work in ornithology, on August 5, aged eighty-one.

Prof. A. L. Selby, emeritus professor of physics in University College, Cardiff, on July 22, aged eighty-one.

Prof. R. Willstätter, For. Mem. R.S., formerly professor of chemistry in the University of Munich, on August 3, aged sixty-nine.

Sir Francis Younghusband, K.C.S.I., K.C.I.E., distinguished for his explorations in south-eastern Asia, on July 31, aged seventy-nine.

NEWS and VIEWS

Astronomy on Postage Stamps

THE dedication of the Mexican National Astrophysical Observatory at Tonanzintla in February last has been marked by the issue by the Mexican Government of a series of six postage stamps devoted entirely to astronomical subjects. The 2c., 5c., 10c., 20c. and 40c. stamps depict respectively the dark nebula in Orion, the solar corona as seen at a total eclipse, the open spiral nebula in Canes Venatici, the edge-on spiral nebula NGC 4594, showing absorption in the central plane, and the ring nebula in Lyra. The 1 peso stamp, departing from the principle of showing spectacular objects such as these, is an experiment which must surely be unique in philately; it depicts the Hertzsprung-Russell diagram connecting stellar luminosity with spectral type, with the main sequence, the giants, the supergiants and the white dwarfs all duly labelled. The significance of this diagram will certainly escape all but those fairly well grounded in astronomy, but the ordinary user of the stamps of lower denominations cannot fail to be impressed by the grandeur of the objects shown.

Functions of Works Managers

IN his speech in the House of Commons on July 22 on the work of the Factory Department of the Ministry of Labour and National Service, Mr. Ernest Bevin paid a well-deserved tribute to works managers. The works manager, he asserted, deserves more recognition than he had yet received, and the country owes much to him in this War, as well as to the mines manager, for overcoming problems which no Government department, scientific worker or technician could have foreseen. There is a very close understanding between the Factory Department and the works managers, who have much in common, being trained, to a very large extent from the same personnel and thus understanding not only each others' problems but each others' approach to the problems. He drew a distinction, which he thinks industry will have to face in the future, between what he called the working directorates who understand the actual operations of the job and he put these working directorates in the same category as works managers. He also emphasized the value of the newly established Factory and Welfare Board as a safeguard against rigid bureaucratic methods. It gives industry and public service a proper place in this branch of administration, and Mr. Bevin thinks that a board of this character will remain a permanent feature to enable us to surmount the changes and difficulties which will arise in our industrial system in the vexed and difficult times ahead. Referring to the Department's policy in encouraging the establishment of personnel managers in the larger factories, he believes that too much is often imposed on the works manager in receiving deputations and like matters and being expected to run the works as well. Much specialization is essential in handling such problems, and the personnel manager as part of the executive is a great asset in large works. Referring to hours of work, Mr. Bevin said that production and mobilization of man-power have now reached a point when matters can be tightened up in respect of hours of work, and the trend of his speech indicated a welcome determination to deal firmly with the question of excessive hours, which are so important a factor in absenteeism and in low production.

Cork Substitutes

As a result of the War, imports of cork have almost, if not entirely, ceased in various parts of the world. Consequently, ingenuity has had to be exercised in providing substitutes. For obvious reasons stoppers for bottles were one of the earliest articles for which replacement was required. One of the countries effected was India, where the imports of cork from Europe very soon ceased, and the need for a substitute material for use as stoppers in different types of bottles, and as liners for bottle crowns and so forth, became keenly felt. The Forest Research Institute at Dehra Dun took up the matter, as explained in a Leaflet No. 6, Utilisation ("Note on Some Experiments on Cork Substitutes", by Dr. N. Narayanamurti, J. N. Pande and D. C. Roy (Research Institute, Dehra Dun, 1941). Experiments were conducted on the production of corks made of wood, composition corks made of disintegrated tree barks and pith corks for hypodermic tabloid tubes. So far, experiments have shown the following suitable substitutes. Bottle stoppers: stoppers of *Cryptomeria japonica* wood suitably slotted and softened by chemical treatment; crown cork liners: composite cork made from *Erythrina suberosa* bark and bagasse fibre have been found suitable; corks for tabloid tubes: paraffin-impregnated sola pith is suitable. The methods of manufacture of these substitutes are described.

Nature Reserves Investigation Committee

A Nature Reserves Investigation Committee has been established with the following membership: Sir Lawrence Chubb (chairman), Mr. G. Dent, Capt. C. Diver, Mr. J. C. F. Fryer, Mr. N. B. Kinnear, Prof. W. H. Pearsall, Dr. J. Ramsbottom, Prof. James Ritchie, Prof. E. J. Salisbury, Dr. G. F. Herbert Smith (honorary secretary), British Museum (Natural History), London, S.W.7.

The object of the Committee is to examine proposals for the establishment of nature reserves as part of any general scheme of national planning; and to obtain information from such bodies or persons as may be directly or indirectly concerned with the formation, organization, or administration of nature reserves or sanctuaries. In particular, the Committee will inquire into the types and approximate areas of reserves and sanctuaries which should be provided to ensure the preservation of communities or species; the species of plants and animals which are in danger unless special arrangements are made to secure their preservation and reproduction; the localities where such reserves and sanctuaries should be situated; the extent to which the public should have access to the various reserves; and the most appropriate methods for acquiring, financing and administering the reserves.

Scientific Film Conference

The first Scientific Film Conference in Great Britain met in the County Buildings, Ayr, during August 1 and 2. In Ayrshire there are four scientific film societies in operation, while an Army and an Air Force camp also arrange periodic shows of scientific films. The Conference was attended by forty-three delegates appointed by the film societies, universities and technical colleges, research institutes, technical departments of local government bodies and the Association of Scientific Workers. Dr. Norman Wright, director of the Hannah Dairy Research Institute, Mr. Arthur Elton and Dr. Blodwen Lloyd presided at the three sessions held on August 1. The delegates decided to form a National Federation of Scientific Film Societies, which would co-ordinate the activities of a Scottish and an English association of such societies. The great need for the increased production and showing of good scientific films was stressed by Mr. Elton (Ministry of Information) during a symposium on "The Scientific Film", to which Miss Mary Field (Gaumont British), Dr. A. Clow (University of Aberdeen), Mr. Stewart Paterson (Ardrossan S.F.S.) and Dr. B. Lloyd (Glasgow S.F.S.), among others, contributed papers. There was general approval of a resolution that both the winning of the War and the planning of post-war reconstruction require the application of the scientific method, and that a wider understanding of this method could most readily be achieved through the medium of the film.

Library of the Philippines

Colonel C. P. Romulo, formerly a publisher in Manila, now aide-de-camp to General MacArthur, has reported in the *New York Herald-Tribune* of July 17 that the Japanese have destroyed by fire the Library of the Philippines at Manila. According to Colonel Romulo, the aim of this vandalism is to obliterate all reference to the United States and Great Britain and anything savouring of Anglo-Saxon culture and democracy. With this aim in view, the occupying forces have formed a Text-book Board comprising seven Japanese and three Filipinos, which is expected to see that no reference to the above countries or culture shall be available in schools. Colonel Romulo was awarded the Pulitzer Prize for 1941 for his interpretative articles on Japanese aims. It will be remembered that university buildings in Manila escaped damage during the attack on Manila (Nature, July 4, p. 20), and it would appear that the destruction of the Library referred to above occurred after the Japanese occupation.

Bournville Village Trust

Under the title "Sixty Years of Planning: the Bournville Experiment", the trustees of the Bournville Village Trust have issued an admirable illustrated account of the development of Bournville from the building of the factory there by Richard and George Cadbury in 1879, when the first houses were also built to provide accommodation for those of the workmen who had to live near the factory (Bournville Village Trust, Birmingham 30). Bournville Village as we know it to-day dates from 1895, and the land and houses were transferred to an independent body, the Bournville Village Trust, when the success of the Bournville Estate seemed assured in 1900. The trust deed laid down the broad lines of future development, and this pamphlet shows the many sides of the work at Bournville in their true perspective. Housing schemes, the reconditioning of slum property and the planning of both municipal and private developments, as well as research into building and planning properties all find some mention in a book which is of real topical value apart from its historical aspect as a popular account of a great pioneer development. The illustrations of amenities, community activities, the planning of and provision for recreation, as well as for cultural needs, the treatment of transport and road problems and the preservation of the countryside show what is possible with vision and forethought, and should give a further stimulus to that growing movement to use to the full the opportunities which the tragedies of war itself now afford us of rectifying the mistakes and failures of the past and our failure to plan harmoniously either the industrial towns or the countryside of Great Britain.

Indian Farming

The journal *Indian Farming*, now in its third year of publication, is issued by the Imperial Council of Agricultural Research of India and is a praiseworthy attempt to bridge the gap between cultivator and scientific worker. It is a monthly with a pleasant appearance of format and is copiously illustrated. It includes articles on breeds of Indian livestock, livestock products and crops, and the erosion problem receives due recognition. Shorter articles and reviews from all parts of the country help to provide a reasonably full conspectus of Indian agricultural problems and of the manner in which technical effort is being directed to meet them. All original papers have a practical bias, as, for example, the recent paper entitled "More Light on the Red-spot Epidemic", by B. L. Chona and G. W. Padwick (**3**, 70–73; 1942). This gives details of the infection of sugar-cane by *Colletotrichum falcatum*, which has led to sudden and almost complete failure of the variety *Co* 213 over a wide area: a new strain of the fungus, not observed before the epidemic, is described. A note on animal quarantine in the Provinces and States discloses that the Central Provinces alone have anything like a comprehensive organization. As a good example of the educative article may be mentioned "Propagation of the Apple in Kumaun", by R. S. Singh. The solar treatment of loose smut of wheat—a method evolved at Lyallpur from Jensen's hot-water treatment—has been described by J. C. Luthra (**2**, 416; 1941); it is very effective and furnishes a striking instance of extreme simplicity in a control measure well adapted for farmers. A new heavy-yielding and strong-growing variety of sugar-cane (*Co* 421), described by Ch. Kh. Mohammad (**2**, 140; 1941), seems to be especially suited to the Punjab, and its seed is being multiplied as rapidly as possible. V. R. Rajagopalan (**2**, 136–39; 1942) has established calcium deficiency as the cause of an outbreak of non-bacterial abortion in equines. *Indian Farming* gives much attention to processing and marketing, including the canning and dairying industries, and the grading of eggs and oranges, and whenever possible simple devices adapted to Indian conditions are described in order that quality shall be improved.

Montesquieu and Medicine

The issue of the bilingual *Schweizerische Medizinische Wochenschrift* of May 2 contains an article in French by Dr. Camille Dreyfus of Mulhouse on this subject, in which he declares that the author of "L'Esprit des Lois" and the "Lettres Persanes" deserves a place in the history of medicine which has not yet been accorded to him. In 1718, the Academy of Bordeaux, of which Montesquieu had been elected a member two years previously, had chosen as the subject of a prize "The use of the renal or atrabiliary capsules", the modern equivalent of which would be "The physiology of the suprarenal capsules". Montesquieu made a report on the essays submitted, in which he showed that none of the competitors was worthy of the prize, which was, therefore, not awarded. His "Observations sur l'Histoire Naturelle", which he submitted to the Academy in 1721, contained microscopical studies of the pigmentations of insects, the parasitic life of the mistletoe, the abdominal circulation of the frog, the foramen ovule and ductus Botalli and experimental researches on the nutrition value of vegetables. In spite of his satires on medical practitioners in "L'Esprit des Lois" and the "Lettres Persanes", it would be wrong to suppose that he was prejudiced against the medical profession generally. In a letter to his friend the Abbé de Guasco, he expressed his admiration and affection for Van Swieten, the celebrated Dutch physician, whom Maria Theresa had invited to Vienna to reorganize medical education. Montesquieu was also a friend of the Chevalier Louis de Jancourt, who contributed articles on physiology and pathology to the "Encyclopédie". The high esteem in which Montesquieu himself was held by a leading medical man of the time is shown by the following appreciation of him by Antoine Portal, the celebrated professor of anatomy at the Collège de France and the Jardin du Roy: "If Montesquieu had devoted himself to the study of anatomy he would perhaps have advanced this science as much as he did moral science." In conclusion, Dr. Dreyfus relates that Montesquieu was the author of a thought which alone should win him immortality: "If I knew something useful to my country but injurious to Europe and the human race, I should regard it as a crime."

American Health in Early War Months

According to an editorial in the April issue of the *Statistical Bulletin*, the organ of the Metropolitan Life Insurance Company of New York, the United States have enjoyed a period of remarkably good health during the months they have been at war. An improvement in mortality-rate during the first three months of 1942 over that in 1941 was reported for almost all the important causes of death, and no less than nine diseases have shown death-rates lower than ever before. These diseases included not only typhoid fever, scarlet fever, diphtheria, whooping cough, syphilis and appendicitis, but also such important diseases as influenza, pneumonia and tuberculosis, in which the mortality has been low in recent years. The 1942 record for the most important diseases of middle and later life, namely, cancer, diabetes and cardiovascular renal diseases is favourable compared with that of 1941, the death-rate from diabetes being down 10 per cent and cancer and the cardiovascular renal diseases each 3 per cent. One of the few diseases to show a rise in 1942 as compared with 1941 are diseases of the puerperal state, of which the rate rose from 4·1 to 4·5 per 100,000, or approximately 10 per cent. It is probable that the increase was due to the rise in the birth-rate and in the number of women exposed to the risks of pregnancy and child-birth. Another group of conditions in which there has been an increase in the death-rate were external causes, with the exception of suicide, which had declined. Homicides and accidents, especially accidents due to motor-vehicles, were higher than in 1941. The war deaths reported to the Company in the first three months of 1942, amounting to 5 per 100,000, accounted for a part of the rise in the death-rate from external causes.

Concrete Simply Explained

This is the title of a booklet which has been published by the Society of Engineers (war-time address, 56 Church Street, Weybridge, Surrey) as reprinted from the *Transactions* of the Society. It was written primarily for the training of concrete operatives by Victor S. Wigmore, and presents the subject in a simple manner which should make it valuable to all grades of workers on the staff of contractors or engineers. The reader is asked to imagine that he is on a site where concreting is about to take place and he is then introduced in turn to each of the ingredients—cement, sand, coarse aggregate and water—and finally to different processes of concreting.

Each section has been treated very thoroughly and in considerable detail as, for example, in the section dealing with cement, where the reader is informed regarding the best method of storing the bags to keep them dry and to facilitate their progress to the mixers. The usual procedure of taking a sample for test, the tests applied, and the processes of setting, hardening and ripening are explained and some warnings given as to possible mistakes such as that of allowing aluminous cement and Portland cement to be mixed together. In a similarly thorough and practical manner the other ingredients and the work of concreting are described and explained. As, in the rebuilding of our towns after the War, concrete will play a very important part and there will be a demand for men who know how to make concrete of first-class quality, it is to be hoped that civil engineering contractors will distribute this booklet widely among their staffs and responsible workmen.

Variations of Geomagnetism

H. D. Harradon, Department of Terrestrial Magnetism, Carnegie Institution of Washington, has given a short account of this subject (*Sky and Telescope*, 1, 8; June, 1942), commencing with the discovery of the secular variation by Henry Gellibrand in 1634—a discovery of considerable importance, especially for mariners. Since no observations are available prior to this date, attempts have been made to extend our knowledge of the earth's magnetism to earlier times by the study of the magnetization of eruptive rocks, baked clays and ancient potteries. In quite recent years magnetic data have been obtained from successive lava flows of Mount Etna, the assumption being that the lava retained the direction of the earth's magnetic field at the time of its solidification, but unfortunately the results have proved rather indefinite. More promising lines of research are found in the study of layers of Pleistocene clays from an old glacial lake near New Haven, Conn., and also of sediment taken from the floor of the Atlantic. In the latter case, where several thousand years of deposition were represented, there is the suggestion of a possible variation in direction of magnetization amounting to more than 60°—the greatest range in secular variation ever recorded. No theory up to the present has explained the mystery of these secular variations; they are probably connected with changes in the interior of the earth, regarding which there is mere speculation. The transient variations, among which the solar and lunar diurnal and the annual variations are the chief, are discussed, and a number of useful diagrams and charts illustrate the connexion between magnetic storms, auroral displays, sunspots, etc.

Horticultural Work on the Amaryllidaceae

Vol. 8 of *Herbertia*, the year-book for 1941 of the American Amaryllis Society (Pp. 180. Hamilton P. Traub (editor), Orlando, Florida), includes several short papers of scientific interest. W. M. James and F. T. Addicott have studied the causes of sterility in interspecific crosses within the genus Nerine, and find a possible explanation in the presence of extra chromosomes in some parents. There appears to be no correlation between chromosome numbers and flowering period, though there is a sharply marked geographical difference between early flowering species and later blooming kinds. J. Marion Shull shows that early flowering species of Hemerocallis have made their flower initials by the previous autumn, whereas later flowering kinds have no floral initiation at that time. "Food Manufacture and Flowering in the Daffodil", by Dr. John Grainger, relates climate, photosynthesis and flower formation. It is found that floral initiation begins when carbohydrate content of the bulb is maximal. The daffodil appears to provide a very efficient photosynthetic mechanism, and its carbohydrate is completely mobile. Optimum conditions for photosynthesis are provided by a high daily average of sunshine and a relatively low average temperature between 40° and 50° F. Albert W. Close directs attention to the use of sphagnum moss for the germination of seeds of difficult species, and the method has the advantage of almost eliminating the damping-off disease. Numerous shorter papers give information on various Amaryllid clones, their combination in breeding, and practical culture. The Society's score-card method for the horticultural evaluation of daylilies has been extended to Florida by John V. Watkins, Hamilton P. Traub and Wyndham Hayward.

Periodic Comet Forbes, 1929 ii

Harvard College Observatory Card 626 announces that van Biesbroeck found this comet as a fifteenth magnitude object on a pair of plates exposed at the 24-in. reflector, Yerkes. Its position on 15 June ·34763d. was, R.A., 0h. 04m. 25·11s., Dec. – 4° 50′ 18·7″. The comet showed a short tail 1′ in length in position angle 270°. In the "Handbook of the British Astronomical Association", 1942, Mr. F. R. Cripps has given the elements of the orbit and also an ephemeris from which the object was easily found. Perihelion passage occurred only half a day earlier than was assumed.

Announcements

Sir Harold Scott, director of the Bureau of Hygiene and Tropical Medicine, is retiring on August 31. The Secretary of State for the Colonies has appointed Dr. C. Wilcocks, assistant director of the Bureau, to be acting director.

The medical faculty of the University of Basle has conferred an honorary doctorate on Prof. Eugen Pittard, rector of the University of Geneva, on the occasion of his seventy-fifth birthday, in recognition of his services to anthropology.

Dr. S. F. Dorey, chief engineer surveyor of Lloyd's Register of Shipping, will deliver the Parsons Memorial Lecture of the Institute of Marine Engineers on September 16. The lecture will be on "Reduction Gearing for Marine Steam Turbines", and will be delivered at the house of the Institution of Mechanical Engineers.

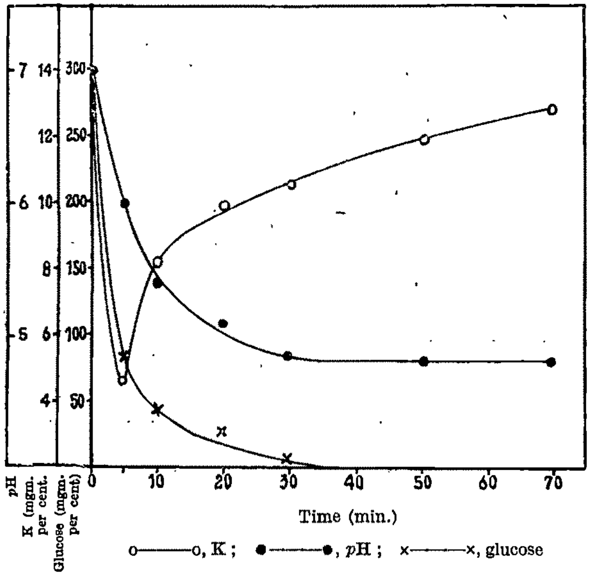
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Potassium in Bacterial Fermentation

Verzar and Pulver[1] discovered that alcoholic fermentation by living yeast cells is accompanied by a striking shift of equilibrium between extracellular and intracellular potassium. The beginning of fermentation is marked by a vigorous intake of potassium from the surrounding medium. With the progress of fermentation the potassium is again liberated from the cells. No plausible explanation of this phenomenon has as yet been advanced.

It now appears that the 'potassium effect' is not confined to alcoholic fermentation by yeast but represents a general feature of glycolytic processes. We were able to demonstrate exactly the same phenomenon in the desmolysis of sugars (glucose, maltose) to lactic acid, hydrogen, etc., by *E. coli*. The accompanying table and diagram are representative of a series of experiments which yielded analogous results.



A suspension of *E. coli* in a solution of $M/60$ glucose, $M/250$ potassium chloride, $M/30$ (NaH_2PO_4-Na_2HPO_4), *p*H 7·05, was incubated at 41°; glucose and potassium were determined in samples drawn from the solution and cleared by centrifuging.

The intrinsic nature of the relationship between the 'potassium effect' and sugar metabolism in the bacteria is demonstrated by the following facts: (1) no such effect occurs when fermentable sugar is omitted from the phosphate-potassium chloride medium; (2) different experimental factors (temperature, *p*H, substrate concentration, aerobiosis or anaerobiosis) exert a parallel influence upon both fermentation-rate and potassium absorption.

Time (min.)	Glucose mgm./100 c.c.	Potassium mgm./100 c.c.	*p*H
0	300	13·9	7·05
5	79	4·7	6·00
10	43	8·2	5·40
20	32	9·9	5·10
30	9	10·4	4·81
50	0	10·9	4·80
70	0	12·9	4·80
90	0	13·5	4·80
120	0	13·8	4·77

The first period of fermentation is marked by a rapid and steep decrease of potassium in the medium. Then the process is reversed, the absorbed potassium being gradually released. The initial conditions are restored simultaneously with, or shortly after, the end of fermentation. At the turning point of the process, that is, at the maximum potassium intake and the beginning of potassium release, the fermentation substrate is still far from exhausted and acid production is still vigorously continuing. Therefore it is clear that the absorption of potassium is connected with some initial phase of the reaction chain of fermentation.

During the brief period in which potassium absorption occurs, glucose disappears from the medium at a rate far exceeding its 'fermentation-rate', as measured by acid formation. This discrepancy in the reaction balance could be accounted for by the detection of the formation in the cells of a non-reducing, hydrolysable polysaccharide which disappears in later stages of fermentation. *The conversion of sugar into a polysaccharide in the initial stage of sugar desmolysis has thus been established by us for bacterial fermentation*, as it has been for alcoholic fermentation in yeast and for glycolysis in muscle by Willstätter and Rohdewald[2,3]. There is a close coincidence in time between the maximum of polysaccharide accumulation and the maximum of potassium absorption in the bacteria. It seems reasonable, therefore, to ascribe to potassium a specific function in the synthetic reaction with which fermentation begins.

A detailed report on this investigation will be given elsewhere.

J. Leibowitz.
N. Kuperminitz.
Department of Hygiene and Bacteriology,
and
Chemistry Department,
Cancer Research Laboratories,
Hebrew University,
Jerusalem.
June 18.

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[1] Verzar and Pulver, Nature, **145**, 823 (1940).

[2, 3] Willstätter and Rohdewald, *Z. physiol. Chem.*, **247**, 269 (1937); *Enzymologia*, **8**, 1 (1940).

Thio-Ureas as Goitrogenic Substances

An attempt to isolate the goitrogenic substance present in rape seed[1,2] suggested the possibility of its being a derivative of this urea. Allyl thio-urea was therefore tested. Doses of 20 mgm. were given to rats daily by stomach tube for a period of eight weeks, after which the thyroids were examined. They had an average weight of 43 mgm., this being three to four times the normal weight. Histologically, the glands show extreme hypertrophy and hyperplasia, and almost complete loss of colloid. The administration of 50 mgm. daily by stomach tube, for ten days, produced identical histological changes in the thyroid, although the weight of the gland is not so great—average of 30 mgm. per 60 gm. body weight. This dose had no toxic effect. Preliminary experiments with 200 mgm. of thio-urea daily for ten days have produced similar results. The changes in both thyroid and pituitary are similar to those produced by feeding rats a diet containing rape seed[2,3].

T. H. KENNEDY.

Thyroid Research Department,
New Zealand Medical Research Council,
University of Otago Medical School,
Dunedin, N.Z.
June 8.

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[1] Hercus, C. E., and Purves, H. D., *J. Hyg.* (Camb.) **36**, 182 (1936).

[2] Kennedy, T. H., and Purves, H. D., *Brit. J. Exp. Path.*, **22**, 241 (1941).

[3] Griesbach, W. E., *Brit. J. Exp. Path.*, **22**, 245 (1941).

Oxidation by Copper in Alcoholic Medium

NOT many examples of redox catalysis in non-aqueous solutions are known. The oxidation of ascorbic acid by copper in absolute ethyl alcohol is interesting because in many respects it resembles the corresponding oxidation in aqueous systems. In the experiments to be described, the absolute alcohol solution of ascorbic acid contained 1 mgm. of the acid per 2 ml. After the oxidation, the unchanged ascorbic acid was estimated by dichlorphenolindophenol titration of a 2 ml. sample diluted by addition of 10 ml. of 0·5 per cent aqueous acetic acid.

No data concerning the solubility of copper sulphate in absolute ethyl alcohol could be found in the available literature. This has been determined by weighing the anhydrous salt remaining after careful evaporation of a saturated alcoholic solution of copper sulphate. The solubility of $CuSO_4.5H_2O$ at 17° C. was found to be 0·0045 per cent, that of anhydrous $CuSO_4$, 0·009 per cent.

Salt dissolved	Conc. of $CuSO_4$	% Oxidation after 5 hr.	% Oxidation in the presence of $5 \cdot 7 \times 10^{-3}$ NaCl after 5 hr.
$CuSO_4.5H_2O$	$1 \cdot 9 \times 10^{-5}$ *M*	0	0
,, ,,	$9 \cdot 5 \times 10^{-5}$ *M*	63·6.	27·2
Anhydrous $CuSO_4$	$3 \cdot 8 \times 10^{-5}$ *M*	40·9	0
,, ,,	$1 \cdot 9 \times 10^{-4}$ *M*	100·0	45·4
Concentration of ascorbic acid $8 \cdot 5 \times 10^{-4}$ *M* in all cases.			

The catalytic action of copper sulphate is shown in the accompanying table. From this table also the inhibiting influence of sodium chloride can be seen. This influence is identical with the action of sodium chloride in aqueous systems.

Even greater than the activation of copper sulphate alone is that given by the pyridine-copper sulphate complex obtained by the action of pure pyridine on anhydrous copper sulphate and evaporation of the excess of pyridine. The crystalline salt so obtained was deep blue in colour and similar to salts obtained by Lang[1]. It contained $CuSO_4$ and pyridine in equimolar proportions. The solubility of this complex in absolute alcohol is 0·022 per cent, giving a greater amount of $CuSO_4$ in solution than did copper sulphate alone.

At a concentration of anhydrous copper sulphate of $8 \cdot 04 \times 10^{-5}$, 35·7 per cent of ascorbic acid was oxidized during six hours; at a concentration of copper sulphate – pyridine complex corresponding to a $CuSO_4$ concentration of $9 \cdot 06 \times 10^{-5}$, 100 per cent oxidation was found after 15 minutes.

Pyridine alone has also a catalytic effect, the concentration required to produce a given amount of oxidation being 1,000 times as great as that of copper sulphate.

It is noteworthy that these effects of pyridine and pyridine – copper sulphate complex in alcohol are quite different from those in aqueous systems, where pyridine alone (possibly by binding Cu) inhibits ascorbic acid oxidation, and the copper sulphate–pyridine complex is much less active than corresponding concentrations of copper sulphate alone.

Water present in alcoholic systems up to 1 per cent has no influence on the rate of oxidation. Higher percentages activate the oxidation, but this phenomenon is complicated by *p*H changes.

A full account of the work with the theoretical considerations will be published elsewhere.

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[1] Lang, W., *Berichte*, **21**, 1578 (1888).

Percentage of Water in Jelly-Fish

A LIVING specimen of *Aurelia aurita* about 4 in. in diameter was weighed by the displacement method[1] and the percentage of water found by distilling it under xylol[2]. The result was: water, 95·56 per cent; residue, 3·87 per cent; giving a difference of 0·57 per cent.

Since the distillation was carried out in what was practically a closed still, nothing should be lost. The difference, 0·57 per cent, represents (*a*) a trace of fat or other material dissolved by the xylol, and (*b*) a trace of water adhering to the rather large vessel which had to be used. The gonads would contain a trace of fat. The residue consists of salts, 3·2 per cent, leaving 0·67 per cent of dry protein; and since living material, such as muscle, in most marine animals, approximates to water 80 per cent and protein 15 per cent, we conclude that the 0·67 per cent of dry protein corresponds to about 4 per cent of protoplasm.

A number of distillations were carried out giving similar results, and it was intended to clinch the matter by carrying out a Kjeldahl estimation for nitrogen, but unfortunately no more living specimens arrived in the laboratory.

Some rather misleading statements have been made about Aurelia, and unfortunately these are finding their way into text-books. It has been stated that "The jelly-fish contains 99·8 per cent of water" and "The organic material in the body of medusæ amounts to less than 1 and most often to less than ½ per cent". Bateman[3] has criticized the first statement and shown it to be incorrect, but from theoretical grounds alone 99·8 per cent water is an impossible figure for Aurelia, for (*a*) an animal comprising 99·8 per cent water would float in the sea with a substantial portion of its body out of the water, which Aurelia does not do; (*b*) the density of Aurelia has been found, and it is obviously close to that of sea-water, which is 1·027 at 13° C. at Plymouth; if Aurelia were composed of 99·8 per cent water with a density of 0·99941, the density of the remaining 0·2 per cent would have to exceed that of mercury; (*c*) since Plymouth sea-water itself contains only 96·8 per cent of distilled water, surely this is the upper limit for any marine organism living in it.

We may conclude therefore that Aurelia comprises about 96 per cent water, 3 per cent salts, a trace of fat varying with the state of the gonads, and about 4 per cent of protoplasm.

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[1] Lowndes, A. G., NATURE, 141, 289 (1938).

[2] Lowndes, A. G., NATURE, 148, 594 (1941).

[3] Bateman, J. B., "The Osmotic Properties of Medusae", *J. Exp. Biol.*, 9, 124 (1932).

Check-list of British Birds

MR. SETON GORDON, in his review of a "Check-List of British Birds" in NATURE of July 11, 1942, p. 40, remarks that, according to Cameron of Lochiel, the last year the osprey bred on Loch Arkaig was in 1908, and not 1902 as given by Mr. Witherby. There seems, however, to be some confusion regarding these dates. I was at Achnacarry for ten months from October 1902, and in the spring of that year the eggs were taken by a man from Fort William, who swam out to the island where the nest was situated. To guard against that happening again, the present Lochiel's father instructed his forester to put barbed wire round the lower part of the tree, and this I helped him to do.

These precautions were, unfortunately, unnecessary, as only one osprey returned in 1903, and I first saw it on April 15. It remained about the Loch throughout the summer, and several times I watched it fishing, also bringing sticks to the old nest which, by the end of the season, was about a foot higher.

For how many years the single bird returned to Loch Arkaig I have no personal knowledge, but I have been told that the last time it was seen was in 1910.

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Regarding the above, Lochiel writes to me as follows:

"This shows the efficacy of the Secret Security Service set up by my father and continued by myself to keep the facts about the ospreys nesting absolutely *secret*. My father died in November 1905. We married in March 1906, and did not take up residence at Achnacarry until 1907, yet my wife remembers well seeing the ospreys and their nest on repeated occasions. As she was never at Achnacarry before we married and never saw an osprey in her life anywhere else, this surely is sufficient proof. Again, Norman MacRae (my piper and butler) also bears me out. He was never at Achnacarry before 1906 and his wife came to Achnacarry on October 31, 1907 (the ospreys always left before the end of September), yet they both remember the ospreys well, and going to see the nest. Mrs. MacRae, therefore, could not have seen them before the spring and summer of 1908. There is no possible doubt: the ospreys nested until the summer of 1908."

It is quite possible that, as Mr. Kinnear states, the osprey did not nest in 1903, but it is evident that they nested in the following years. Lochiel was living at Achnacarry and, as I know, always took a great interest in the birds, so it is inconceivable that both he and the witnesses he has quoted should be in error.

SETON GORDON.

Encouragement of Research in Industry

SIR LAWRENCE BRAGG says in NATURE of July 18, p. 75: "Lip service is paid to research because it is respectable and fashionable to do so, but responsible industrialists in private express their disappointment." That inventive talent is lacking seems doubtful. Even under conditions of complete detachment a continual flow of ideas cannot be maintained indefinitely; but when questions of plant, personnel, materials and time limit exist to cramp the style, a considerable proportion of the industrial scientist's fund of originality has to be transferred from the purely progressive to the task of adaptation to rapidly changing conditions. Provided the right men have been selected on the production side all is well; but if the research and development men are confronted with too much opposition to change, they will quickly become discouraged. It is, after all, their job to make improvements.

As to whether industrialists provide the right sort of conditions, it would probably be true to say that, on the whole, industrialists do not quite understand the research man, stand to some extent in awe of him, and thus fail in part to stimulate "the flow . . . of fundamental ideas which would profoundly affect our industries". The director of a few years ago who, showing a visitor round his works, stopped and asked of one of his research chemists: "Well, my man, and what have you discovered to-day ?", is not entirely extinct. But probably the root of the problem lies in the delegation of insufficient responsibility to research workers, even long after these have 'found their feet'. The suppression of executive ability in men of proved research capacity is surely to be deplored in many cases. Latent powers should be allowed for in men in harness, lest they remain too much in grooves.

It may help certain types of inventive genius to be assisted by a limited number of persons entirely devoid of original thought. These should be selected for their ability to interpret the wishes and record the ideas. To some extent they also act as a foil, but their importance is none the less on that account.

The industrialist who has not enjoyed a scientific training must find it hard to grasp the enormously dynamic nature of original research, or, when he sees frenzied activity over some apparently trivial matter, wonders whether sufficient eye is being kept on the main chance. Bearing in mind that 'spontaneous' research is bound to flow more readily than 'research to order', the time allowed for the latter should be on the liberal side. To some extent the research worker should be definitely encouraged to develop sidelines which spontaneously arise, as so much time would be wasted if at a later date he were asked to develop just that feature from scratch. It would be gratifying to think that research was sufficiently treasured in Great Britain to ensure facilities for developing what might be termed the 'overflow' of ideas of scientific workers engaged on specific products of research. Just as in chemical plants, 'waste' is frequently utilized to produce marketable by-products.

In many respects scientific workers themselves would get on faster if only they spent a small fraction of their time in striving each week for some improvement in their department. When actually engaged on research, they covet a lack of interruption. Then why not plan to be 'not available' at certain hours of each day ? An interrupted train of thought may mean ideas lost for good under present-day hectic conditions. It is, then, in the industrialist's interest to come to an understanding, so far as practicable, with his scientific personnel, on mutual intercourse. The use of a typist should by no means be restricted to purely clerical work. How many of Wordsworth's gems would have been lost to posterity were it not for sister Dorothea capturing the flowing words. If typists are not denied to directors and if poets find them useful, then surely the research scientist while manipulating should be encouraged to declaim his readings, his observations, his trains of thought to a shorthand typist seated within unobtrusive earshot.

Finally, it is possible that when engaged on pressing priority work, men will be tempted to work so fast that their readings are not properly recorded. This tendency to relapse into scrap-of-paper habits should be resisted firmly. One never knows when the story as a whole may not be wanted.

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Science and Education

SCIENCE in relation to education has been prominent in NATURE for many months, but one aspect of the matter seems to me to deserve more attention: the social and historical setting of science. Sir Richard Gregory said[1]: "One reason why few men of science care to take an active part in politics, is that they do not feel able to effect [such] a transfer of their trained habits of thought" to the consideration of social and political problems. It certainly seems true that very few men of science can effect this transfer; nearly always judgment is heavily influenced by some bias, necessarily subjective. Moreover, this applies equally to men of letters, to men of business, to men in every walk of life. Therefore, we must think, not only of fitting the scientific man to play a conscious part in history, but also of giving the scientific outlook to the historian and the classic. When these men of the 'humanities' view social development with the same critical objectivity as the scientific man, they will be less likely to misguide us. The historian particularly needs the scientific attitude; for example, it is incredible that H. A. L. Fisher could write in 1936 ("History of Europe", p. 1207) on Hitlerite Germany: "Some items, such as the Second Punic War with England and the war of revenge on France, are no longer regarded as likely to be remunerative. Far more promising as a means of augmenting the territory of the Third Reich is the expedient of the plebiscite."

Now, I suggest that the inability of the man of science to carry his trained habits of thought into other fields, and the entire lack of the scientific attitude on the part of others, is due to the isolation of the several subjects in the schools during the formative years. The error of the schools is not that they give too much time to any one subject, but that they fail to integrate them all into a single whole. How can this be remedied? The progress of science is contained in the advance of history, and itself helps to shape that advance, affecting every branch of human culture. On this ground I make the following suggestions: (1) The approach to science should be historical, the fundamental principles being studied in their historical order, against a background of contemporary social development. Apart from the basic reason for this, any branch of science becomes more real, and so more interesting and educative, if studied in this way. (2) To effect the above there must be complete correlation between the science class, the history class, the literature class, etc., the several syllabuses being planned as parts of one whole, bringing out the mutual actions between the various forms of social activity, in such a way that the student applies the scientific method of thought to all his studies. (3) Modern ideas on science, not always more difficult to understand than the concepts of classical science, should be included, impressing on the student that no theory, however well established it may seem, can be final. (4) Science must be understood to extend beyond the confines of physics, chemistry and biology, to embrace all social phenomena, involving the introduction of elementary instruction on statistics. In the study of human behaviour, the student should acquire the same attitude of mind as in his study of physical or chemical phenomena; theory must be tested by experience, both in the continuum of social history and the laboratory.

There should be no difficulty in finding time for such a programme, if it be recognized that the achievement is not to be a vast store of factual knowledge, but an understanding of principles and methods, and appreciation of the part played by science in shaping human society, and the ability to find factual knowledge when it is required. Least of all should we move towards vocational teaching in the primary or secondary school.

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[1] NATURE, March 7, 1942, p. 261.

Prof. A. R. Forsyth

MAY I correct Prof. Chapman on two minor points (NATURE, 150, 49; 1942)? Forsyth's Calcutta lectures, published in 1914, were on the theory of functions of two complex variables. His treatise on differential geometry, published in 1912, that is, before he went to Calcutta, is described in the preface as consisting of the substance of lectures delivered during his tenure of the Sadlerian professorship at Cambridge. In his retirement Forsyth produced, not two treatises, but three, the third, which appeared in two volumes in 1935 with the somewhat misleading title of "Intrinsic Geometry of Ideal Space", being an extension to n dimensions of the analysis which for three dimensions and for four had been developed in earlier works.

I would not impertinently praise Prof. Whittaker, but as I am writing I should like to express the indebtedness of all for his masterly discussion of the decline of Forsyth's reputation. We all know that fifty years ago Forsyth's name stood internationally for English pure mathematics; we needed to be told that it stood worthily.

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RESEARCH ITEMS

Rice Field Insects

AN interesting Circular, No. 632, under this title by W. A. Douglas and J. W. Ingram, has been issued by the United States Department of Agriculture (Washington, D.C., 1942) which should prove of interest outside the United States. "Insect enemies of the rice crop differ", say the authors, "somewhat from those of other field crops and the methods of controlling them are different, because the rice fields are kept flooded with water during most of the growing period." Insect damage to growing rice is caused mainly by four species: the rice stinkbug (*Solubea pugnax*), two species of lepidopterous stalk borers (*Diatrœa saccharalis* and *Chilo plejadellus*) and the sugar-cane beetle (*Euetheola rugiceps*). There are other insects capable of inflicting some damage if the conditions of their environment become eminently favourable, but these four are of chief importance. The stinkbug sucks the contents from the developing rice grain, causing a total loss of all grains so attacked in an early stage of their development. The stalk-borers feed within the rice stalk, resulting in the loss by death of the developing rice panicle. The adult sugar-cane beetle gnaws young rice plants prior to the flooding in the spring, and newly emerged adults attack the nearby mature stalks when the field is drained prior to harvest; the stalks fall over and are thus prevented from being picked up by the harvesting machinery. All the important insects attacking rice in the field are alluded to but the above four are fully described and methods for their control are given. This circular makes its appearance at an opportune moment—since the rice crops of the United States and India must be of the first importance to the Allied Nations.

Hatching of Eggs

PARTRIDGES and grouse usually hatch 100 per cent of their eggs whereas domestic fowls frequently only hatch 75–90 per cent. R. K. Cole has discovered one reason for a reduced proportion of hatched eggs (*J. Hered.*, 33, 83–86; 1942). A lethal gene—talpid—was found in pedigrees of fowls showing infertility of a proportion of the eggs. Talpid causes the embryo to develop in an extremely abnormal manner. Most talpid embryos die about the eighth day of incubation, but a few may survive until the seventeenth day. The lethal gene is known to have been in the stocks of hens at Cornell for at least eight years.

Genetics of Natural Population

Linanthus Parryœ is a diminutive annual member of the Polemoniaceæ. It is found in the Mojave Desert of California, and has white or blue flowers. The numbers of the annuals vary considerably from year to year according to the amount of rain in the desert. In the locality studied by C. Epling and T. H. Dobzhansky (*Genetics*, 27, 317; 1942) the population can be considered an isolated one. Sampling of 427 stations, each half a mile apart, was made and involved 126,100 plants. A total of 113,955 white- and 12,145 blue-flowered plants were found, but the distribution of the two types was not uniform. Indeed only 108 blue plants were found outside three distinct and separate areas. A typical *U*-shaped curve of the frequencies of blue-flowered plants in the sub-populations indicates that small size of population is the chief contributory cause of the irregular proportion of blue- and white-flowered plants in the sub-divisions of the area.

A Cancerous Neoplasm of Plants

PHILIP R. WHITE described "A Cancerous Neoplasm of Plants Produced by Autonomous Bacteria-free Crown-Gall Tissue" in a paper read before the American Philosophical Society on April 24. Cancer is characteristically an independent and unrestrained, unphysiological, invasive, and malignant growth. Primary crown galls of plants possess to a marked degree the last four of these characteristics. They cannot, however, be considered independent, since they are caused by a bacterium, *Phytomonas tumefaciens*. Nevertheless, on certain hosts, especially among the Compositæ, there occur in many cases of crown-gall infection secondary tumours of unknown etiology arising at a considerable distance from the point of inoculation. Work carried out within the past two years has shown that tissues derived from these secondary tumours are bacteria-free by both bacteriological and serological tests. Tissues from the interior of secondary tumours have been isolated and grown *in vitro* for more than a year. In tissue culture they grow much more rapidly and in a much less organized manner than do tissue cultures taken from non-tumorous tissues. These tissue cultures can be grafted into either sunflower or artichoke plants, where they produce typical crown-gall tumours. Gall tissue can be transplanted from sunflower to artichoke and vice versa. In both hosts, as well as *in vitro*, they retain their characteristic independent, unrestrained and unphysiological manner of development. Their invasiveness is restricted by the rigid skeletal framework in which plant cells are regularly constrained to function, and their malignancy is likewise restricted by structural characteristics of plants. Nevertheless, it is believed that the cells of these tumours and of the tissue cultures derived from and giving rise to them, possess all the essential characteristics of cancer cells and therefore represent a new and potentially useful material on which to study the etiology of cancer.

Auriculas

THE neat growth and pleasing flower colour of garden auriculas result from some interesting structural mechanisms, which are discussed in a short paper by Sir Rowland Biffen (*J. Roy. Hort. Soc.*, 67, Pt. 6, June, 1942). Beautiful variations in flower colour are caused by the combinations of several factors—an imperial yellow colour, an anthocyanin (hirsutin), a buff yellow colour, and a white ground. Presence or absence of wax or 'meal' in the centre of the corolla also makes an additional contribution, while green, grey and white-edged forms are brought about by the plants' occasional demonstration of the foliar nature of the corolla lobes. Green-edged and grey-edged flowers occasionally occur on the same plant, and when this happens, the former spring from the base of the plant, while the terminal flower is grey-edged. A curious factor results from the presence of a 'paste' in the centre of some flowers, and there is evidence that this is a further indication of the leafy origin of the corolla. Chlorophyll may also occur in sections of the corolla other than at the edge. Zoned flowers thus arise, and another mutation gives striped flowers. The interactions of all these and other factors are discussed in the paper.

New Types of *Datura Stramonium*

Albert F. Blakeslee and A. G. Avery described "Nine Strikingly Diverse Types in *Datura Stramonium* with Location of their Determiners in a Single Chromosome" in a paper before the American Philosophical Society on April 24. The mutant characters discussed show wide departures from the normal type. One which has smooth, in distinction from spiny, fruits, has been classified as a distinct species, *Datura inermis*, although it differs from normals by only a single gene. This gene causes many changes beside the elimination of spines on fruits, such as shortening and thickening of petioles and internodes, increased inequality in paired branches, broadening of leaves, flattening of stigma and delayed fruiting. A type with short flowers and broad leaves is indistinguishable from another type which is determined by a different gene in another chromosome. A type which wilts in sunlight also mimics two other types brought about by different genes. One type induces early fruiting. A type has been called 'sickly' because its appearance resembles the effects of a virus disease or the environmental influence of lack of certain elements in the soil. One type usually branches with three, instead of two, forks but the environment affects the forking since plants which are genetically 3-forked occasionally have only two forks and normal plants may sometimes show three forks without being able to transmit the character to their offspring. One type brings about doubling of the chromosome number in eggs and pollen, one the production of lobed instead of round pollen grains and one causes the early death of the pollen grains affected without injuring the egg cells. By the breeding behaviour when extra chromosomes are present and by linkages between the characters in their inheritance, it has been shown that these nine types are determined by genes located in the 11·12 chromosome and at least eight of them in the ·12 half. It has been further possible by these methods to establish the approximate order and position of these genes within the chromosome.

The Lewiston-Auburn, Maine Earthquake of March 8, 1942

This earthquake has been investigated by William H. Weeks, *S.J.*, of the Observatory of Weston College, Massachusetts (*Earthquake Notes*, 14, No. 4; April 1942). The data used were the seismograms obtained at the observatory at Weston College, together with the returned questionnaire cards supplied by the United States Coast and Geodetic Survey, with which the epicentral region was canvassed. At Lewiston, near to which the greatest intensity was attained, small objects and vases were overturned and a few dishes broken. This indicates intensity IV on the Rossi-Forel scale. The sound which accompanied the earthquake was like "snow falling from a roof". The shock was registered on the seismograms at Weston at 23h. 38m. 32s. U.T. and appeared to come from an epicentre some 128 miles north-east by north of Weston. From all the data the epicentre appears to have been near latitude 44° 10′ N., longitude 70° 14′ W., which is about nine miles north-west of Lewiston, and the origin time 23h. 37m. 59s. U.T. Captain Heck notes that this district had not been entirely free from earthquakes during the last three hundred years, and that an earthquake disturbed approximately the same area on February 5, 1929.

Order in the Alloy Cu_3Au

Electron diffraction by the transmission method has been applied by L. H. Germer, F. E. Haworth and J. J. Lander (*Phys. Rev.*, 61, 614; 1942) to investigate superstructure as produced in the alloy Cu_3Au by various heat treatments. One of the purposes of the work was to extend the field of usefulness of electron diffraction by applying it to material which has been studied for many years by means of X-rays. The customary limitation of electron diffraction to the study of surface phenomena only is believed to be unjustified. Cu_3Au was chosen because it still presents unsolved problems in spite of many years study, because in the superlattice which is formed the copper and gold atoms can readily be distinguished by their widely different scattering powers and because the alloy is fairly resistant to corrosion. The changes up to 560° C. have been studied in detail. There seems to be no sudden change in the diffraction pattern corresponding to the alleged Curie point of order. The methods developed in the research are suggested as applicable to other alloys and to mixtures of metal salts.

Active Nitrogen

Two more papers in the series by Lord Rayleigh on active nitrogen have appeared (*Proc. Roy. Soc.*, A, 180, 123 and 140; 1942). From the experiments reported in the first paper, it is clear that the behaviour of the glass walls is very complex. Traces of oxygen or other impurities affect primarily the walls of the vessel and not the phenomena in the gas space. By a special device it is shown that when the behaviour of the gas is studied away from any surface, purest nitrogen is the best, and no favourable effect in promoting the active nitrogen phenomena is produced by adding a trace of oxygen. The second paper deals with the ionization associated with after-glowing nitrogen. It is found that this ionization is completely cut off if the testing vessel is separated from the after-glow by a silica wall. The ionization cannot therefore be directly produced by light within the range from λ 1850 to the visible. No increased current is observed when the surface action of the active gas is so vigorous as to make the testing cathode, of gold, red hot.

Stress Systems in Aeolotropic Plates

The stress distributors in an infinite plate containing a circular hole are greatly modified when the plate is no longer isotropic. A. E. Green continues the theoretical solution of such problems as may arise when a rivet is driven into a hole and pulled sideways (*Proc. Roy. Soc.*, A, 180, 173; 1942). The aeolotropic plate is assumed to have two mutually perpendicular directions of symmetry. Some examples of stress distributions are included which have non-zero force resultants on the edge of the hole, corresponding to cases in isotropic materials for which the solution is dependent on Poisson's ratio. The use of the complex variable makes the method of solution comparatively simple, and as an introduction to the work for an aeolotropic material the same method is applied to problems of stresses in an isotropic plate containing a circular hole in order to obtain results which Bicksley (*Phil. Trans.*, A, 227, 383) previously found by another method. Numerical work is carried out using the elastic constants found in experiments with specimens cut from the highly aeolotropic materials, spruce and oak.

EARTHQUAKES IN THE UNITED STATES DURING 1939*

A BOOKLET recently issued by the United States Coast and Geodetic Survey, entitled "United States Earthquakes, 1939", contains a very full account of the seismological activities of the department during 1939, together with a complete summary of the major results obtained. An important feature of the work is that it is fully co-operative with all interested in seismology, including the Weather Bureau, the Jesuit Seismological Association at St. Louis, universities, engineering companies, insurance companies and like commercial concerns, Science Service at Washington, the Seismological Society of America and interested individuals.

First come the non-instrumental results, chiefly obtained by the return of questionnaire cards by voluntary observers to local centres. This work is now fully systematized, and exceedingly useful results are obtained. In the booklet there is first a summary of the earthquakes according to the States concerned, the list including Alaska, Hawaiian Islands, Panama Canal Zone, the Philippine Islands and Puerto Rico. There follows a more detailed list classified by regions, dates, and the intensities of the shocks according to the modified Mercalli intensity scale of 1931. From this work it appears that the destructive and near destructive earthquakes of the United States during 1939 happened mostly in four large regions, which may be identified with (1) California, (2) the Appalachian Mountain region from near Chattanooga to near Boston, thence at right angles towards Montreal, (3) near the Mississippi–Ohio junction close to the rivers between St. Louis, Louisville and Memphis, and (4) the heights of the Rocky Mountains. Additionally, there were scattered epicentres throughout the country, probably the greatest being the one near Charleston.

Several universities and institutions send their seismograms and seismogram readings to the U.S. Coast and Geodetic Survey, and these are checked and printed along with the results obtained from the Survey's own teleseismic instruments. Altogether twenty-two observatories are involved in this way. From these readings along with those contributed by the Jesuit Seismological Association and others interested, epicentres throughout the world are calculated. In the publication under notice a complete list of such epicentres is printed for the years 1938 and 1939. Many of these have been mentioned previously in the columns of NATURE.

In order to furnish data suitable for the use of engineers, architects and others interested in the design of earthquake-resisting structures, the Survey instituted in 1932 a programme of strong-motion seismograph work. This makes use of seismographs placed in areas particularly susceptible to earthquakes, the seismographs being so designed that they only begin recording when the motion becomes sufficiently pronounced, and so that they are not unhinged by earthquakes such as are likely to occur (NATURE, Nov. 8, 1941, p. 551). The records obtained are interpreted on the assumption that the motion is simple harmonic, and the details published for each prominent pulse on each seismogram are: (1) earth wave period, (2) maximum acceleration, and (3) maximum displacement, together with remarks pertinent to the wave. During 1939, eight such earthquakes produced good strong-motion results. These were as follows: (1) Imperial Valley earthquake of March 21, which was recorded on the accelerograph at El Centro, some 24 miles N. 7° E. of the epicentre, the record showing a maximum acceleration on the horizontal component of about 26 cm./sec.^{2}. (2) Imperial Valley earthquake of March 24, showing details similar to (1) above. (3) San Diego County earthquake of May 1, recorded on the accelerograph at San Diego some 53 miles N. 23° E. of epicentre, with a maximum acceleration of about 3 cm./sec.^{2} on the north-south component. (4) Earthquake of May 4 near Boulder Dam recorded on the three accelerographs at Boulder Dam some four miles approximately N. 72° E. of the epicentre. The accelerograms here show the short-period motions characteristic of local earthquakes, the maximum acceleration being about 43 cm./sec.^{2} on the vertical component at the intake tower. (5) Western Nevada earthquake of May 11. This was recorded on the accelerograph at Hawthorne, Nevada, which is about 42 miles S. 85° W. of the epicentre, the maximum acceleration being about 8 cm./sec.^{2} on the horizontal components. (6) Northern Californian earthquake of June 22, with an epicentre off Cape Mendocino and recorded on the accelerograph at Ferndale. The maximum acceleration was about 15 cm./sec.^{2} on the south-west component. (7) San Diego County earthquake of June 24, which was recorded on the accelerograph at San Diego some 53 miles N. 23° E. of the epicentre. The motion on the accelerogram was somewhat irregular, the maximum acceleration being about 5 cm./sec.^{2} on the north-south component. (8) Southern California earthquake of December 27 with epicentre near Long Beach. This was recorded on the accelerographs at Long Beach, Vernon, Los Angeles Chamber of Commerce, Los Angeles Subway Terminal, and Hollywood, and on the displacement meter at Los Angeles Subway Terminal. At Long Beach, some three miles S. 75° W. of the epicentre, the maximum acceleration was about 14 cm./sec.^{2} on the east-west component. At Vernon, some fifteen miles N. 16° W. of the epicentre, the maximum acceleration was about 9 cm./sec.^{2}. At the Los Angeles Chamber of Commerce, some nineteen miles N. 22° W. of the epicentre, both the basement and the 11th floor accelerograms show irregular motion on the horizontal components, while the vertical components show a number of waves with 0·15 sec. period. At the Los Angeles Subway Terminal, about twenty miles N. 20° W. of the epicentre, the basement accelerogram and displacement meter records show small activity of an irregular character except on the vertical accelerogram. The 13th floor accelerogram shows considerably more motion, irregular on the south-west component, but comparatively regular on the others. At the Hollywood Storage Co., about 24 miles N. 29° W. of the epicentre, the seismograph on the adjoining lot and that in the basement of the storage building agree in showing slight motion of irregular character. The motion recorded in the penthouse is stronger and of comparatively long period, and is rather irregular except on the east-west component, which shows a maximum acceleration of about 3 cm./sec.^{2}. Several tracings of the accelerograph records are figured in the text. Maps with isoseismals are also given for the important earthquakes during the year.

During 1939, three tiltmeters were kept in operation on the grounds of the University of California at

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* "United States Earthquakes, 1939", by Ralph R. Bodle. (Washington, D.C.: Government Printing Office.) 20 cents.

Berkeley with the active co-operation of the Seismological Station at that institution (Prof. Perry Byerly). Two required visible readings but a third automatically recorded pictures of the interferometer fringes every hour. No outstanding tilts could be associated with local earthquake activity. From October 1938 until January 1939 a triangulation resurvey was made of certain monuments in the locality between Petaluma and Point Reyes, California, originally established in 1928; about fifty stations were occupied. It is intended that periodic re-observations of this scheme will be made so that knowledge of possible earth movements may be obtained.

No tidal disturbances of seismic origin were noted on the gauges of the Bureau and co-operating stations during the year. One earthquake was reported felt by a vessel of the Coast and Geodetic Survey. This was on August 19 at Dutch Harbour, Alaska. Those aboard the ship felt four or five jolts.

ENTRY OF YOUTH INTO INDUSTRY

THE importance attached to the welfare of youth was reflected in the recent debate in the House of Commons on the Education Estimates; few of the many aspects of reconstruction problems after the War are more vital than that concerned with the welfare of youth. The memorandum on the problems of post-war entry of juveniles into employment, prepared by the London Regional Advisory Council for Juvenile Employment and recently submitted to the Ministry of Labour and National Service, emphasizes a vital aspect of juvenile welfare to which Political and Economic Planning directed attention in an admirable report, "The Entrance to Industry", so long ago as 1935. The memorandum adds little to what is contained in that report, but its arguments are ably reiterated. They are still valid, for while some progress has been made in regard to the provision of the social services required, we have scarcely begun to implement the long-term programme envisaged in the P E P report. Any charter of youth that may be promulgated will fail of its purpose if it does not receive the fullest consideration of all that is implied in the vital question of entry into employment. The plea of the London Regional Advisory Council that the economic aspect of the life of youth should not be neglected in the midst of educational, social, athletic or other preoccupations is indeed opportune.

Recalling the recommendation of the Malcolm Committee that education, whatever form it takes, should be related to the needs and circumstances of life, which for a vast majority of boys and girls means life spent in industry or commerce, the memorandum suggests that training for life implies a preparation for citizenship in the broadest sense, and that such training should be an integral part of the life of the school and of the curriculum in extension of work done in earlier services, the whole method and practice being linked with material services, such as fine school buildings, physical and recreative work, music, free meals, and also with the other social services. There should be an attempt in the last period of this portion of school life to ease the transition from school to the larger world outside through the creation of a club atmosphere, accompanied by corresponding modification of the curriculum.

While occupational guidance might be given in the schools by specially qualified teachers, no attempt should be made at direct training for livelihood except in schools directly concerned with technical training. In regard to part-time schools, the memorandum emphasizes that the main function is to continue the general education of the pupils, particularly in the broad aspects of citizenship; also that if the day continuation system is to be well and truly established, it must receive the wholehearted support of employers. It is to be hoped that the social conscience will finally reject the notion that if the young worker wants continuative education, it is his own business to seek it in the evening after a full day's work.

The particular difficulty which the small employer and small working unit present in this respect is recognized, as are those inherent in reconciling the claims of industry and education. The Council suggests that the position of the young person in industry should be regarded from the broad point of view of entry into employment, conceived as a continuous process moving by degrees from school life, through the sphere of youthful work, into the wider world of adult labour. It suggests the extension of the school medical service for the physical well-being of all minors, or at least medical examination so as to ensure that all juveniles are physically suited to enter the employment of their choice. Welfare work in industry should be closely related to the true needs of young workers; and to correct the excessive tendency to enter clerical occupations rather than trades the memorandum advocates the establishment of vocational training schemes based on expert sifting and guidance and the closest liaison with those responsible for apprenticeship.

The memorandum touches on a number of points in war-time experience such as the Essential Work Order, which may contain elements of permanent value for juveniles, and it directs special attention to three sections of the field common to education and industry of which little is heard: the need for a new outlook on the whole question of apprenticeship; the need for greater mobility of labour to meet unexpected changes in economic organization and location of industry; and the need for ensuring that those who have entered employment as 'learners', in the widest sense of the term, shall be equipped with that degree of adaptability which will enable them to meet the demand of any sudden turnover to new materials or fundamental revision of technique, as, for example, the changes which are bound to come as a result of the ever-increasing use of synthetic materials. These are questions of increasing significance, and it is essential that education and industry should work closely together in this field if the problems arising from them are to be solved. While deprecating pressure for too rapid development after the War, the Council would welcome and support any scheme calculated to secure the growth of a sympathetic understanding by teachers and educational administrators of the needs and problems of business and industry, and it is urged that such mutual relations should be fostered and encouraged.

The problem of youth in industry is essentially a question of entry into employment. The employer must consider the position of his young employees as an integral element in his management and organization. This will require the closest liaison and fullest co-operation between associations of employers and the trade unions to raise the entry into employment of juveniles to the status of industrial relationship. At the same time, education authorities must face the realities of the economic world which the juvenile will enter or has recently entered. The day continuation school may become a real meeting-ground between the two worlds of education and industry if it is administered, not merely as an educational service, but also as a means of recovery and refreshment for the young worker. Until, however, the problem of entry into employment is tackled by all concerned as part of industry as a whole, all elaborations of the machinery of choice of employment and vocational guidance will be vain and its products largely a matter of hazard.

HOUSEHOLD LIGHTING, HEATING AND VENTILATION

PAPERS read at two of the series of twelve meetings of the Royal Society of Arts recently devoted to "The Post-War Home: Its Interior and Exterior", have now been published (*J. Roy. Soc. Arts*, June 26). R. Fitzmaurice, principal scientific officer at the Building Research Station of the Department of Scientific and Industrial Research, gave a lecture on the lighting, heating and ventilation of the ordinary house. Many facts of topical interest relating to domestic use of fuel and power were included. Non-functional design of working kitchens leads to needless waste of lighting. Plans are reproduced of the distribution of daylight in ill- and in well-designed kitchens using the same ground-plan with redistribution of the same areas of glass in the walls.

All three subjects are intimately related. Large window areas or windows opened for ventilation may lead to excessive use of fuel for heating. It is estimated that about half the total quantity of coal raised in Great Britain is used for providing warmth in buildings, the remaining half being used for power and heat in industry. Although Germany has a colder winter and maintains better heating conditions in buildings, the consumption of coal for heating per head of the population is considerably less than in Great Britain. Less use of open fires and increased use of smokeless fuel help economy. From a graph reproduced it is shown that in the last forty years the price of coal in London has more than doubled.

The very variable nature of the British climate is an obstacle to the use of some highly efficient heating systems. For example, in the United States, Germany and the U.S.S.R. centralized heating of a whole district from a single boiler house is practicable. It is well known that large plants need to work as nearly as possible to their capacity to obtain a high order of running efficiency. In Great Britain, however, an installation capable of handling the heating load during our relatively limited cold weather would not be running nearly to its capacity over the greater part of the heating season.

Contributions to the discussion included one by R. Grierson, of the Northmet Power Company, who gave details for the small house. The lowest amount spent per year for heating services—coke, coal, gas and electricity—is about £7–£8 a year. The ordinary clerk or member of the lower-paid professional classes spends £15–£20 per year. Mr. Grierson gave full details for his own house, where £28–£30 a year is spent in heating its 12,000 cubic feet of space. For windows, a glass area of about 20 per cent of the floor area under normal conditions gives adequate natural lighting. A ratio of 12½ per cent makes a room definitely too dull.

The common type of German stove "is not a thing of beauty, but it does make for efficiency (45–70 per cent) and reduces the amount of heat energy lost up the chimney. If the Englishman gets 20 per cent of the heat energy of the coal into the room, that is to say, if he gets 12*s.* worth of heat out of £3 worth of coal, he is fortunate". In view of the national requirements in the economical use of fuel, these figures give food for thought.

A serious difficulty lies in the fact that the initial expense of the more efficient heating devices in a home is always greater than that of the inefficient. Similarly, a further wastage occurs in cheap roofing of houses. After the War of 1914–18, many cheap houses were built with roofs of tiles on laths. No lining of felt or other material under the tiles was used. As a result, the wind blows right through the loft space, the water in the cold storage tank is frozen in the cold weather, and the bedrooms are separated from an atmosphere which during last winter fell in temperature to 14° F., by about three quarters of an inch of lath and plaster ceiling. Such rooms—similar conditions also occur in living-rooms in cheap bungalows—are in effect fitted with panel-cooling; for it is found that on a hot day, if the temperature of the ceiling is only 10° F. below that of the room, the cooling effect is most marked.

Mr. A. F. Dufton, also from the Building Research Station, found that a gas fire, designed to burn 0·2 therm an hour (5–8 kw.), had to be used for two hours in all in order to warm a room for half an hour for breakfast, so long as the walls remained in their original condition, consisting of plaster and wall-paper. When, however, the heat absorption of the walls was reduced by lining them with wood panelling, half an hour of previous heating instead of the original one and a half hours sufficed.

The eleventh lecture in the series was given by Miss Helen Masters, who dealt with equipment and maintenance in the kitchen. While the heat requirements for cooking are here again of great importance, many other factors are involved. The mere accumulation of labour-saving devices, without organization of the work to be done, will not promote efficiency. Architects have sometimes given so much attention to reducing the number of steps to be taken in walking from one part of the kitchen to another that they have designed kitchens which are too small to work in at all.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

THE South-Eastern Union of Scientific Societies held its forty-seventh annual congress at Guildford on July 25, a single day of sessions and excursions attended by seventy representatives and members.

A representative assembly to transact the business of the seventy constituent societies was held in the County School for Girls, at which Dr. J. Ramsbottom, keeper of botany at the British Museum (Natural History) was elected president of the Union for 1942–43; in recent years he has served the Union as president of the Botanical Section. The new treasurer is Sir Gordon Hearn.

"Fungi and the Biology of Man" was the title of Dr. Ramsbottom's presidential address. He stated the facts concerning struggle and survival in fungi, the existence of races and their immutability, parasitism and symbiosis in outline: points of similarity and of contrast in man were indicated. Man does not inherit acquired characters in a biological sense, but he is heir to every other change. No pure races of man exist and the theory of race and blood is nonsense. Competition or struggle is universal, but in symbiosis an equilibrium has been attained. Competition in modern man is, for the most part, sociological and not biological. The State is an organization and not an organism. War between States is not a biological necessity nor is it transcendental. Man has his full complement of biological characters at birth: they are immutable. His ideas, his theories, his wishes are developed through culture: they can be changed and therein lie the hopes of civilization.

At the sectional sessions the following papers were read: "Historic London under Fire", by E. Yates, who exhibited the deplorable damage to medieval buildings caused by enemy action; "Studies in the Variation of Native Plants", by Dr. A. R. Clapham, who advocated co-operation by botanical societies for the proposed new Biological Flora of the British Isles (*J. Brit. Ecol. Soc.*, 356; 1941); "Constructional Elements in the Physiography of the Southern Counties of England", by F. Owen Whitaker; "Spiders and their Life History and Habits", by E. A. Robins, who described a spider new to the British list, *Marinda aurantia*, the golden garden spider of America.

In the afternoon, Dr. W. St. Lawrence Finny, the retiring president, conducted a perambulation visiting and describing the history of St. Mary's Church, Guildford Castle and Museum, the Guildhall and its regalia and the Abbot's Hospital of 1619. Botanists visited the Compton district; geologists the Guildford brickworks and the Lower Greensand beds at Compton. It had been suggested that this Congress should be at Haslemere but, this being impracticable, the zoologists went there by train to see exhibits arranged in the Haslemere Educational Museum. There was a special exhibit of native flowers arranged by the Guildford Natural History Society, the officers of which organized local arrangements, and it was pleasing to see flowering specimens of our ancient woad, *Isatis tinctoria* L., now classed in most Floras as "a casual alien". T. DANNREUTHER.

THE ONTARIO RESEARCH FOUNDATION*

THE report of the Ontario Research Foundation for the year 1941 includes the report of the Director, the audited financial statement and a list of publications issued to December 31, 1941. During the year the work of the Foundation has been increasingly concerned with problems associated directly or indirectly with the War, and owing to the nature of much of the work in this field, as well as on problems of civilian production arising out of war-time restrictions on supplies of all kinds, a detailed reference to much of the work is not possible. The creation of centralized inspection laboratories has relieved the staff of much of the work in organizing and conducting laboratory work on behalf of the Inspector-General, but the securing and training for effective service of young graduates and technicians is a serious problem, although problems associated with personnel have been considerably reduced by the help of the local Registrar for Military Service. The quick and effective results which follow from full co-operation between men with long experience in industry and a scientific group actively engaged in research on the processes and materials of the industry have been demonstrated, and although it is clear that relations with industry require further development, the Director suggests that problems of the post-war period will afford a further opportunity for economical and effective work along these lines.

In the Department of Biochemistry, the Leather Laboratory has been used to varying extents by the Department of National Defence and the Inspector-General, and work on Service specifications has been continued in collaboration with the National Research Council. Preliminary tests have been made of a modified abrasion-testing machine for leather, and the production of organic acids from sugar by chemical and microbiological methods has continued. Methods for crude and refined lactic acid are now in use on a commercial scale in Toronto. A good deal of time has been devoted to a careful comparison of chemical and microbiological methods for determining the vitamin B_1 content of foodstuffs, including bread. In the Department of Agriculture, the Pathological Laboratory has investigated the infection of small experimental animals with *Ascaris lumbricoides*, and the same Department has now completed the greater part of its field work on the climate and main soil types of southern Ontario, and in co-operation with the Federal Department of Entomology has made a rapid survey of southern Ontario to determine the location and extent of nematode infection in oats.

In the Textile Department a reasonable balance has been maintained between testing, short-term problems and more fundamental research, and an investigation has been undertaken on the treatment of various synthetic fibres to overcome the serious drawback that they cannot be given a high degree of twist in their natural state without serious troubles developing in the knitting operation, and encouraging results have been obtained in collaboration with the Dominion Silk Mills, Ltd. Partly successful attempts have been made to obtain new products for processing wools from raw materials which are and will be available in Canada.

In the Department of Chemistry, the organic and metallurgical analytical laboratories have continued to operate on behalf of the Inspector-General and there has been a marked increase in the number of problems submitted by outside firms. The Gas Laboratory has given several months to the study of steaming of horizontal retorts at one of the plants of the Consumers' Gas Company, and in the Department of Metallurgy gauge-testing, heat-treatment, physical testing and metallography services have been available to Government departments and manufacturers, and the long-term research programme has largely been brought to a standstill.

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* Ontario Research Foundation. Report for the Year 1941. Pp. 25. (Ottawa, 1942.)

AUTOMOBILE RESEARCH

A CONSIDERABLE amount of the work at the Research Laboratories of the Institution of Automobile Engineers is being done for Government departments, and since it is of a confidential nature may not be shown to a visitor. Nevertheless, at the recent inspection of the laboratories by members of the Automobile Research Committee and representatives of affiliated firms, there were several important investigations to be seen in actual operation. Usually, work of this nature arises directly out of the problems of the industry either in the form of an explicit question such as that of the fatigue strength of crankshafts, or from the more nebulous query as to whether aeration of the lubricant is a determining factor in the cause of bearing troubles, and these two cases are representative of the work being done at the Institution's Laboratory.

Three investigations into the aeration and frothing of lubricants were to be seen in operation on the above occasion. In the Chemical Laboratory, tests were being made to ascertain the frothing tendency of different oils at atmospheric pressure but variable temperature. In the Chassis Laboratory, a transparent bearing of plastic material has been arranged so that the behaviour of aerated oil can be observed, and it was of interest to note that, under the limited conditions permissible, the oil film at the pressure side was not ruptured. In the General Laboratory, a typical installation comprising a tank, aero-engine sump, oil cooler, pumps and filters has been set up in order to study the effect of high altitudes on the frothing occurring in an aircraft engine lubricating system. It is intended to run this at reduced pressures and to observe the amounts of froth formed in different parts of the system.

An investigation of a somewhat related character is that on the durability and wear of bearings, for which machines of two types have been developed. In these the test bearings are in the form of bushes cast or inserted in a steel shell and fitted as the big end of a connecting rod. As an extension of the work on these two machines, tests on full-size engine bearings are in prospect on another machine of special design by which an alternating load is applied by an external lever arrangement. This machine is in the experimental stage, and it was particularly interesting to observe the electric strain gauge developed for measuring the actual load applied to the bearing and the torsionmeter for the cyclic torque variation. Both measurements are made while the machine is in operation.

Fatigue tests on full-size crankshafts are carried on in machines which are arranged so that one throw alone is under test at a time, thus enabling a number of separate investigations to be carried out on one multi-throw shaft. The machines are of the constant-strain type, and the method of test involves the repeated application of a known deflexion to the crank under test. Piston-ring scuffing is being studied in a single-cylinder water-cooled engine, arranged so that the jacket temperature and quantity of lubricant supplied can be varied under control. A gas producer of the Government "Emergency" type is being used to supply gas to a converted petrol engine in an investigation to ascertain the power loss involved in the conversion, and the methods by which this loss can be made good.

In addition to such work as is described above, the Laboratory staff is actively engaged in the preparation and circulation of abstracts of current technical literature bearing on matters affecting the automobile industry. Inquiries for technical information are dealt with by the library staff; the library contains a valuable collection of text-books, periodicals, pamphlets, research reports and reference volumes, thus providing the basis for the information service which supplements the research work of the Committee.

EARTHQUAKE ACTIVITY IN NEW ZEALAND

AN earthquake of considerable intensity shook the southern part of the North Island of New Zealand at approximately 11.35 a.m. local time on August 2. The epicentre of the shock was considered in New Zealand to have been some fifty miles from Wellington. The country districts most affected were Manawatu and Wairarapa, where the damage was considerable, though not on the same scale as at Wellington. The shock was estimated to have been as severe as that on June 24 (Nature, July 4, pp. 18–19) though, according to human perception, it was of shorter duration. During the June earthquake damage was done to post office and power lines and water supplies, and many buildings were cracked. During the August shock hundreds of chimneys fell, many windows were broken and several of the buildings damaged in June were so severely shaken that it is likely they will have to be demolished. Some streets were temporarily closed to traffic and the City Engineer estimated that the damage in Wellington may run into hundreds of thousands of pounds.

The Dominion Observatory at Wellington has just (1942) published Bulletin No. *S*-64, "The Seismicity of New Zealand", by R. C. Hayes, which divides the islands into four seismic zones having marked differences in seismicity. Bastings has stated that the seismicity of New Zealand as a whole is high compared with other countries, due mainly to the relatively large number of earthquakes of the semi-destructive type. The seismicity of any region is governed by both the maximum intensity of the shocks which occur and the frequency of the earthquakes. In the work of Hayes, the relative seismicity is obtained by multiplying the average number of shocks per decade (1835–1940) in the area of Rossi-Forel intensity 10 by 10, the average of intensity 9 by 2, and adding these to the average number of intensity 8. Freeman's work had previously shown that earthquakes of R.F. intensity 9 are twice as destructive as those of intensity 8, and those of intensity 10 are ten times as destructive as those of intensity 8.

The average number of earthquakes per year (1921–40) is considered separately. Whenever earthquake swarms such as that in the Taupo region in the latter half of 1922 occur, only the stronger ones have been considered. On these facts, the four regions are: (I) The northern half of South Island and the south-eastern half of North Island with Cook Strait in the centre. This has an average of 97·8 earthquakes per year, and a relative seismicity of 11·5; (II) the central portion of North Island, average 23·0 earthquakes per year and relative seismicity 1·1; (III) the whole of the southern half of South Island, average 12·1 per year and relative seismicity 0·1; (IV) the extreme northern tip of North Island, average 1·1 earthquakes per year and relative seismicity 0·0. In region I, the strongest shocks tend to congregate towards the east and south-east though the north-western part has the highest frequency for moderate or small shocks. The difference may be due to differences in the strength of crustal materials. In region II Taranaki is liable to semi-destructive shocks at infrequent intervals, "near" Auckland may have had violent shocks during 1835–36, and New Plymouth in 1819. In region III one semi-destructive shock between Mount Cook and Lake Wanaka has been definitely recorded though heavy shocks in the west coast sounds area have been mentioned in 1792, 1810 and 1826–27.

Earthquakes within about 10° of Wellington during May 1942 numbered 12. The greatest had intensity 4 (Rossi-Forel) on May 10, near Whakatane, and one on May 27 may have had intensity 3 at Upper Takaka. Two shocks on May 7 and May 21 respectively were felt at Rotorua. Additionally, five distant earthquakes were registered by the seismographs at Wellington, Christchurch, Auckland and Arapuni according to the provisional Bulletin *P*-123 published by the Dominion Observatory at Wellington.

ORIGIN OF COSMIC RAYS

A NEW hypothesis of the origin of cosmic rays and reports on its experimental testing in India and elsewhere are published in the *Physical Review* (61, 397 and 407; 1942) by R. A. Millikan, H. V. Neher and W. H. Pickering. While retaining the fundamental basis of nuclear physics theories and transformations of rest mass into other forms of energy, former suggestions are reversed. The sun's heat is assumed to correspond with atom building going on in its interior, whereas cosmic rays are due to the complete annihilation process going on in interstellar space. The transformation of the rest mass of the atoms into cosmic-ray energy is postulated as *complete* instead of partial.

When the postulates are used, five definite cosmic-ray bands are predicted, each reaching the earth in a particular latitude, and four plateaux of unchanging cosmic-ray intensity, these plateaux being delineated by the latitudes of entrance of the successive bands. The bands are named as (i) a silicon band of energy 13·2 Bev., (ii) an oxygen-nitrogen band of mean energy 7·1 Bev., (iii) a carbon band of energy 5·6 Bev. and (iv) a helium band of energy 1·9 Bev.

To test these predictions it was necessary to measure directly *vertical* incoming cosmic-ray energies as a function of latitude. India is the most suitable place in the world for the most significant of the tests. While in India it takes 17 billion-volt, vertical, charged-particle rays to break through the blocking effect of the earth's magnetic field at the equator, about 13 billion only suffice on the other side of the earth in Peru.

A comparison of theory and experiment was made possible largely through generous support of the research by the Carnegie Corporation of New York, the Carnegie Institution of Washington and the India Meteorological Service. The results so far attained are the detection of the silicon band and the joint nitrogen-oxygen band, with less definite observation of the carbon and the helium bands. The predicted values for latitudes and order of intensity are approximately of the same value as the observed. At least three of the four plateaux of constant cosmic-ray intensity were observed.

In the second paper, by Neher and Pickering, experimental details are given, although full description of the apparatus appears in the *Review of Scientific Instruments* under the title "A Cosmic-Ray Radio Guide" (13, 143; 1942). This instrument is a miniature radio-transmitter recording barometric pressure and atmospheric temperatures as well as the Geiger counter observations. By its aid, Geiger counter and electroscope observations were compared. The counter was found to give results very close to those of the electroscope and of comparable accuracy. When two or more counters are arranged as a cosmic-ray telescope, the radiation from a selected part of the sky only is recorded. Thus the energies recorded are delimited with considerably greater accuracy than by the use of the electroscope.

FORTHCOMING EVENTS

Tuesday, August 25

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 2.30 p.m.—Conference on "Civil Engineers and the Building Industry" (to be opened by Prof. C. E. Inglis, F.R.S.).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant to the Advisory Officer in Plant Husbandry, and an Assistant Lecturer in the Department of Bacteriology—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (August 28).

Assistant to the Chief Research Officer of the Mental Disease Research Department—The Secretary, The University, Birmingham (September 1).

University Chair of Chemistry, tenable at the Royal Cancer Hospital—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (September 1).

Physical Chemist and a Mineralogist or Geo-chemist for research work into materials and processes of the ceramic industries—The Director of Research, British Pottery Research Association, Queens Road, Penkhull, Stoke-on-Trent.

Graduate (man or woman) in Science or equivalent in Engineering, and a Graduate (man or woman) in Science including Biology, and able to assist in General Subjects, at the Mexborough Schofield Technical College—Mr. E. B. Stockdale, Education Office, Mexborough, Yorks.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Reports of the Council and Auditors of the Zoological Society of London for the Year 1941. Pp. 38. (London: Zoological Society of London.) [58

Proceedings of the Royal Society of Edinburgh. Section B (Biology), Vol. 61, Part 3, No. 22: Deficiency Effects of Ultra-violet Light in *Drosophila melanogaster*. By Dr. B. M. Slizynski. Pp. 297–315. (Edinburgh and London: Oliver and Boyd.) 1*s*. 6*d*. [58

Other Countries

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College of Science Physics Dept.

THE MAKING OF A PHYSICIST

THE physicist, like the poet, is born and not made. Neither can be produced, on demand, by any system of training. In each category we have to make do with what Nature, in her wisdom, supplies, and the number in each category is extremely small. As regards the physicist, statistics have recently been given by Sir Lawrence Bragg in a discourse on "Physicists after the War", delivered at the Royal Institution (NATURE of July 18, p. 75). If, following Sir Lawrence, we define a good physicist as "a man capable of independent thought, with a flair for his subject", then in Great Britain "about one good physicist is bred per year per million inhabitants". Assuming that each has a working life of thirty years, this gives us a total of some fifteen hundred professional physicists, an estimate which agrees fairly closely with the records of the Central Register. It is interesting to note that a preliminary survey made some months ago in the United States in preparation for its war effort yields substantially the same proportion. It is possible that a few potential physicists escape the widely flung net of our scholarship system and remain "mute, inglorious Miltons", and it is certain that a small number, owing to accidental circumstances, find themselves engaged as chemists or engineers, but it is unlikely that the grand total of available physicists falling within the scope of Sir Lawrence's definition can be much increased. The total falls much below our present war-time requirements, and well below the requirements of a post-war society in which science will play its proper part.

Fortunately, the situation is not quite so desperate as it seems. The standard set by Sir Lawrence's definition is a high one—there can be few, if any, other professions which make such rigorous demands of their membership—and many of the tasks for which physicists are required, both in the present emergency and in the normal routine of industry, can be very adequately performed by men and women less well gifted. In an attempt to increase the number of young physicists for war purposes, the Board of Education last summer made the experiment of offering State bursaries on a generous scale to all boys and girls reaching a definite standard in physics and cognate subjects in the Higher School Certificate examinations. This has resulted in a very substantial increase in the size of the physics classes in the universities and colleges. The experiment is too recent to allow of a final pronouncement ; a preliminary survey makes it doubtful whether it will add materially to the limited number of "good physicists". There is, however, no doubt whatever that it is adding substantially to the numbers available for the more routine but no less important posts for which originality of a high order is not a *sine qua non*. It may be safely predicted that there will be many such posts in post-war industry ; and these new recruits form a valuable reinforcement to our scientific potential. Their existence will enable us to assign the always strictly limited number of men with a real flair for research to work which they alone can do.

Even with this addition, our assets, in scientific man-power, are small. It is worth while, even in war-time, to spend some sustained thought on the best methods of training and utilization. For the physicist, indeed, the problem is one of particular urgency. To meet the immediate demands for young physicists in the war effort, university courses in physics are being not only curtailed but also rather heavily biased towards specific parts of the subject of immediate application. Thanks to the wisdom and foresight with which the "Hankey training scheme", as it is generally called, has been planned and administered, the courses remain recognizably courses in physics. Broad foundations are being laid, upon which further training can be based when the present emergency is over. It must be recognized, however, that most of the young physicists now hurrying from the universities to take their place in the national effort are far from being fully equipped for the scientific work which they will be called upon to carry out, we may hope, in the post-war reconstruction. If the irreplaceable asset represented by their skill and intelligence is to be used to the full their education must be completed, and their training for new tasks undertaken. There is reason for believing that this necessity has not escaped notice in official circles. Since arrangements, to be effective, must precede the demobilization of the men and women concerned, discussion of the best methods for the education and training of physicists is one of immediate urgency, and the Institute of Physics has been well advised in placing the subject well to the fore on the agenda of its Planning Committee. A memorandum on the subject, prepared by Dr. H. Lowery, has already been circulated to members of the Institute and others interested in the subject. This, together, no doubt, with the very interesting and novel views expressed by Sir Lawrence Bragg in the lecture to which reference has already been made, will serve as the basis for a discussion which the Institute is hoping to hold in the early autumn.

Without venturing to anticipate the results of such discussion, it may be useful to direct attention to a few general principles, since general principles have an uncanny habit of getting mislaid when attention begins to focus itself on details. In particular, the fundamental distinction between education and training is one which is very apt to become blurred. (There is evidence of this in reports of recent, otherwise inspiring, speeches of the President of the Board of Education.) The distinction is of particular importance when dealing with the making of a research physicist. Though his discoveries sometimes lead to considerable advances in engineering, the research physicist is not a kind of super-engineer; in fact, industrialists who try to employ him on engineering work usually find him distinctly disappointing. His real affinity is with the creative artist, and his value to the community lies in the spark of originality which he brings with him into the world. To fan this spark into a flame, to feed it with appropriate fuel, or, to drop the metaphor, to assist the student to develop his full stature as a physicist is our first and most urgent task. Training for a more specific task should follow, not accompany, this process of education. Since the distinction between the "good physicist" and what we may call the routine physicist is one of degree rather than kind, it would appear that the same process should also be applied to the latter, up to the limits of his capacity.

Education, at its best, is a very personal matter, not lightly to be intruded upon by outsiders. The student gains more from contact with the mind and personality of his professors than from their formal instruction. That is one reason why the university department with its happy blend of teaching and research embodied in the same individual affords, on the whole, such an excellent cultural medium for the embryo physicist. There is, of course, no room for complacency. Lacking the centuries of experience which have gone to the perfecting of, say, the teaching of the classics, and faced with the difficulty of teaching a subject which is expanding at an enormous rate, it is not to be expected that physicists should have yet discovered the best ways of presenting their subject. In one particular a grave error has undoubtedly developed. In the attempt to keep pace with the rapid growth of the subject, far too heavy a load has been placed upon the shoulders of the 'honours' physics student. From the moment when he is identified as a possible scholarship candidate to the moment when he emerges dazed but triumphant as an honours graduate, his time has been completely absorbed in his subject. He has not had leisure in which to grow up. "He has not", to quote Sir Lawrence Bragg again, "learnt to mix with other people, and form one of a team, to take responsibility, to trust his own judgment, and have initiative. . . . The industrialist compares him unfavourably with boys who have worked their way up, and become men of the world."

The picture is a little overcharged, and it would be possible to quote many exceptions. That there is much substance in it cannot be doubted. Considerable doubt may be felt as to the efficacy of Sir Lawrence's suggestion that the problem could be solved by interpolating a six months apprenticeship to industry for all honours students between their leaving school and entering the university. Apart from the fact that many educationists would regard a definite break in the student's career at this stage as being undesirable in itself, there is the risk that this preliminary apprenticeship might lead the student to regard his subsequent studies as a training for industrial service, rather than as an education in physics; and to be a little impatient (anyone who has had to teach physics to medical or engineering students will know the symptoms) of matters of no obvious practical or industrial importance. But it is precisely because the physicist, for the sheer love of the subject, has studied many matters of no obvious practical importance that he is able to make his unique contribution to industry. The fact that the charge of immaturity is not, as a rule, levelled at the statesman, barrister, physician or economist who graduates through the universities of Great Britain shows that there is little wrong with the environment itself. The trouble is that, owing to the pressure of work, the physics student has been largely isolated from this environment. The remedy is to lighten the load, and so give him the opportunity to take an adequate part in the non-academic but formative activities which are such a valuable part of university life.

This necessary reform cannot be carried out in isolation—no university will willingly admit that its honours standard is less exacting than that of its neighbours—but it should not be beyond the powers of the universities as a whole to work out an agreed solution. As regards the schools, much might be achieved by the elimination of the present competitive scholarship examinations and the substitution of a system on the lines of the new State bursaries. If every pupil who reached a certain well-defined standard was assured of a university education if he desired it, much of the stress which hampers the real education of the present scholarship candidate would disappear. Any extra expense in which the State might be involved would yield a rich return.

The training of the young graduate for research is generally provided for by allowing him to spend a year or two in research in the university. The system has grown up quite fortuitously, but its value has not been seriously challenged by the industrialist. It would probably be difficult to devise anything better. One proviso, however, must be made. It should be clearly kept in mind by the student, and particularly by the director of research, that these years are years of training. Their object is to produce a research physicist and not a series of "communications". The neophyte should be given a problem which will test his powers, and considerable latitude in handling it. The freedom to make one's own mistakes, though not formally embodied in any charter, plays a valuable part in the process of training. The temptation to use the trainee as an observer in other people's researches should be firmly resisted, and the department should be satisfied to be judged primarily by the quality of the men it produces, rather than by the quantity of original papers it turns out. In this connexion the methods of Sir J. J. Thomson, the greatest trainer of research physicists the world has yet seen, are worth close study.

On the psychological or personal side, it must be confessed, the position is not quite so happy. While the routine physicist, as a rule, settles down quite readily in industry, the research physicist only too often both experiences and creates a certain irritation. The industrialist complains that his new recruit has far too good an opinion of himself. The young physicist, eager to prove his worth and to give of his best, finds himself enmeshed in a system of regulations and restrictions which appear to him to have been specially designed to prevent him from getting on with his work, and very often called upon to do things which seem to him of negligible importance. There is need for adjustments on both sides, if physics is to make its maximum contribution to the welfare of society. Not only must the physicist learn to fit himself for industrial conditions—industry must also learn to adjust its conditions to the physicist. Goodwill is not lacking on either side. The physicist in industry is as keen upon his work, and as rightly convinced of its value, as his university colleague; while our best industrial concerns are genuinely proud of their research departments and anxious for their welfare and efficiency. What is needed is a better understanding of the conditions which are essential to the creative artist (let us strike this note again, for it is the keynote in the situation) if he is to give the best of which he is capable. It may be admitted that the problem of making the necessary adjustments in organization is not an easy one for the industrialist; it requires courage and vision, qualities in which the great industrialist should not be lacking. Progress has been made, particularly in the United States; and some of the larger industries in Great Britain are at least moving in the right direction, with Government research, on the whole, lagging sadly in the rear.

The problem of the best utilization of our limited scientific capital involves more than the provision of the best methods of educating and training the scientific worker himself; the conditions under which his special gifts can find their amplest outlet must simultaneously come under review. It is only as the two aspects of the problem are studied in conjunction that the right solution will be attained.

THE HIPPOCRATIC MYTH

Disease and the Social System

By Arthur Guirdham. Pp. xvi+240. (London: George Allen and Unwin, Ltd., 1942.) 10*s*. 6*d*. net.

It is a pity that Dr. Guirdham does not value his ideas more highly, since many of them are exceedingly good. To recapture the primordial Hippocratic vision, in which specific disease is seen in relation to the total personality, is an idea worthy of serious handling. But the author's staccato, rather malicious, style fails to clothe his ideas with persuasive interest. The satirical mood is convincing only when the author is truly gripped by his vision. But for satire to be effective the cheap sneer must at all costs be excluded. In this work even the chapter headings are not free from this curious vulgarity as, for example, the caption "Lead Kindly Light", above a chapter in which current medical teaching is held up to ridicule.

In regard to his main theme Dr. Guirdham is clearly right when he tells us that we have lost the true perspective, that we no longer see the total human being in our teaching of medicine, but have apportioned man into arbitrary fields for specialists. It must be admitted, however, that the idea was presented better by Plato and with greater economy of argument. In the Dialogues, for example, we find: "But Zamolxis . . . says further that as you ought not to attempt to cure the eyes without the head, or the head without the eyes, so neither ought you to attempt to cure the body without the soul: and this, he said, is the reason why the cure of many diseases is unknown to the physicians of Hellas, because they are ignorant of the whole, which ought to be studied also; for the part can never be well unless the whole is well." Plato then proceeds to affirm the importance of psychotherapy as the fundamental medical approach. "For all good and evil," he asserts, "whether in the body or in human nature, originates . . . . in the soul, and overflows from thence, as from the head into the eyes. And, therefore, if the head and the body are to be well, you must begin by curing the soul; that is the first thing." In this, the very foundation of the true medical point of view, Dr. Guirdham's illumination has not the clear integrity of the Greek vision whence his inspiration is admittedly drawn. Indeed, he reserves his worst venom for modern psychotherapeutic methods, without himself providing any better means for grappling with the problems of the soul than that of masterful hortation.

If Dr. Guirdham's main contention can be substantiated, namely, that the incidence and character of disease have shifted in the direction of the autonomic, endocrine and psychical fields, then the problem of disease in the future will surely demand the fullest possible research into the fundamental psychological determinants of human nature. The historical patterns which determine the character of our social system are part of our psychological inheritance and, since the individual is the unit of society, it must be in the realm of the individual psyche where the tyranny of the pattern can be fought. Logically, therefore, if Dr. Guirdham were to take his ideas seriously, he would be advocating far-reaching research into the nature of the unconscious. He would also insist upon the teaching and practice of psychotherapy as an integral function of the health centres which, in the near future, will determine the character of medical practice. It is just because he breaks his lance against the social windmill that the author fails to convince either himself or his reader that he has any effective remedy for the ills of mankind. His snap judgments and ineffectual satire might even be regarded as the product of Quixotic frustration. He condemns modern man for chasing vague and nebulous goals, but is not the social system, which he himself attacks, the most nebulous goal of all?

The book abounds with dashing generalizations of which the following is a fair specimen: "Psychiatrists should also be historians. The German race for two thousand years have maintained a carefully conceived national policy of brutality, fraud, opportunism, cunning and terrorism. They have lived in the continent which above all others has been throughout the centuries a pioneer in civilization." For how long has the German race been a nation with a "carefully conceived national policy"? What student of history would put his name to such an assertion? Moreover, one of the main reasons for our inability to prepare against the German cataclysm was because we could not believe that Germany could ever be guilty of destroying the very civilization of which she herself had always, and rightly, claimed to be a pioneer. Our present confusion of mind in regard to post-war problems is not unrelated to this suicidal split in German psychology. It is difficult to accept that the upper half of a nation can be civilized while the lower half remains sunk in barbarism. But are we also completely civilized from top to toe? Without the historico-psychological point of view, what hope is there for a fair appraisal of the problems of our time?

Yet, in spite of the author's exasperating recklessness of statement, his book is also rich in good ideas, and if mental stimulation were all one required it would serve remarkably well. H. G. Baynes.

TEXT-BOOKS OF ACOUSTICS

Acoustics

By Dr. Alexander Wood. (The Student's Physics.) Pp. xvi+588. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1940.) 27*s*. 6*d*. net.

A Text-book of Sound

Being an Account of the Physics of Vibrations with Special Reference to Recent Theoretical and Technical Developments. By Dr. A. B. Wood. Second, revised and enlarged, edition. Pp. xvi+578. (London: G. Bell and Sons, Ltd., 1941.) 30*s*. net.

THERE can be no doubt that British text-books of acoustics are the finest published in any language. Most of the best advanced text-books in physics now come from the United States. General text-books in acoustics are still the exception, and the British product is best. For this reason, Dr. Alexander Wood, in writing the latest text-book, set himself a difficult task. The result is completely successful. Modestly stating that the book "makes no claim to originality", he gives the clue to its excellent qualities by explaining that he wrote "primarily for the interest of writing".

The treatment throughout is comprehensive. Theory, experiments and applications are given with references to original sources. Many excellent diagrams, graphs and photographs are included. As the history of each branch is given more fully than in any other British text-book, the student is helped to realize that in science the branches of a subject are developed gradually, that discoveries in another field may suddenly provide just what was wanted to help in the subject of his own special interest. Because of spasmodic developments, the historical presentation of a subject may be too slow for the 'go-getting', examination-pursuing student. The method presents, however, the facts of how a subject develops and of how his own researches will go if he follows any but the path of safety-first.

Much of the beauty of physics lies in the linking together of such diverse phenomena, affecting different sense organs, by a few simple general principles. Vibrations and wave motion unite sound with mechanical, optical and electrical phenomena. The author neglects no opportunity of developing the relationships. For example, the chapter on diffraction includes an experiment in acoustics analogous to crystal 'reflexion' of X-rays. Two minor suggestions may be made. Students would be helped by a collection of problems (a few examples are given in the text) and by an annotated bibliography of the standard reference works in acoustics, including the journals specially devoted to the subject.

Dr. A. B. Wood's "Text-book of Sound", first published in 1930, has since been twice reprinted and now appears in a revised and enlarged second edition. The new edition preserves all the excellences of the old, and there is newer material in such branches as supersonics, hearing, noise and various technical applications. Where the additions do not justify resetting the text, new references to original sources are given.

If comparisons are made, the order of increasing fullness of treatment is Richardson's "Text-Book of Sound", followed by A. B. Wood's, with Alexander Wood's outstandingly mature work giving the fullest treatment of the subject available in English.

W. H. George.

HALLEY'S COMET AND ITS IMPORTANCE*

By PROF. H. C. PLUMMER, F.R.S.

THIS lecture coincides with the bicentenary of Halley's death, for he died, the second Astronomer Royal, on January 14, 1742, at the age of eighty-five. To this office he succeeded Flamsteed, after holding the position of Savilian professor of geometry from 1703 until 1720.

The quality for which Edmond Halley, Hon. D.C.L. of the Queen's College in the University of Oxford, was most remarkable was beyond any doubt his versatility, which ranged far beyond the subjects which are prescribed for this lecture. Thus in the Breslau Tables he made the first contribution of fundamental importance to the science of vital statistics. He was a post captain in the Royal Navy. He gave effective advice to the Emperor on the fortification of Trieste. Here it may be interesting to notice that in this task he was following a tradition which can certainly be traced back to Galileo who, as professor of mathematics at Padua, lectured on the subject of fortification and published a textbook on it.

But here I shall turn to what is probably the most important side of Halley's astronomical work, his discussion of the orbits of comets. This subject has not been dealt with at any length in these lectures, and it is related to a matter which might be regarded as Halley's greatest achievement, and perhaps the most difficult: the tactful handling of Newton and the production from him of his supreme effort.

The appearance of a great comet is an infrequent event, occurring at very irregular intervals. Year by year several comets, say from five to ten, are seen and observed. Some of these even become visible to the naked eye, but they are rarely conspicuous objects. The last comet which earned the title of 'great' was seen in the year 1882. It was notable as the first comet to have its portrait taken. The phrase is appropriate because the portrait was taken by an ordinary professional photographer with an ordinary portrait lens in an ordinary camera strapped to an equatorial at the Cape Observatory. The event signalized the advent of the dry plate, which was destined to re-arm the astronomer with a new weapon. Not that this was the first use of photography in astronomy—it had been employed for several years in the new Oxford Observatory—but it marked the introduction of a far simpler process by a striking example.

In the sixty years which have elapsed since that date, only two comets have excited popular attention in the northern hemisphere, though several have provided notable objects for photographic study. Both of these comets were seen in the year 1910. The first came unheralded, and many will remember its beautiful and impressive appearance in the February of that year. The approach of the other had been followed since the preceding autumn, when it was first detected well within 10′ of its predicted place. For this was Halley's celebrated comet returning from its long journey after seventy-five years absence. Because the nearest approach to the sun took place in April, the appearance of the comet was disappointing in this latitude. But in tropical countries the conditions were more favourable and the spectacle was impressive enough. The February comet will need no further remark, but that it illustrates one point. In order to establish the identity of a comet, much more is necessary than its appearance near an expected date. For the two brightest comets in the last sixty years were separated by no more than three months in the time of perihelion passage.

The history of Halley's Comet has been traced back over more than two thousand years. Of this long period barely the last third is covered by useful European observations. Happily in this instance the balance has been redressed by recourse to the East, for Chinese records have proved invaluable. This is true even in the middle of the period, when Arabian astronomy was in the ascendant. The Arabs, like Ptolemy, do not seem to have paid much attention to comets; any observations made by them seem to have escaped notice, if indeed they were made at all.

Thus the story of a single comet represents a section of astronomical history. In the ancient world perhaps Seneca came nearest to a sensible view of comets, but nothing of real scientific value was possible before the fifteenth century, when the Viennese school became active in astronomy. Its most distinguished product, Regiomontanus, observed the comet of 1472 and wrote on the subject. But his work on comets was not published during his short life-time. To him is doubtfully[1] assigned a limiting parallax which places comets beyond any reasonable boundary of the atmosphere. This deserves notice as an early result of observation. The next step was made by Tycho Brahe, who from observations of the comet of 1577 narrowed the parallax to 1°, and so placed comets beyond the moon. It remained for Kepler, observing the comet of 1607 (Halley) to go further and assign the orbit to planetary space. Thus the seventeenth century started with a fair knowledge of the region in which comets are located. This does not mean that so much was universally accepted: Galileo, for example, entertained ideas which were quite retrograde, even after 1618, when three bright comets appeared.

If sound views on distance were slow in forming, naturally ideas on the nature of cometary motions were even more backward. Tycho supposed the motion circular, and Kepler, confronted by a problem apparently quite unlike that presented by the planet Mars, conjectured motion in a straight line. We shall notice later on that a much sounder view was taken far nearer home. Hevelius in his "Cometographia" (1668) suggested a parabolic orbit, but this was a vague guess which had been anticipated by Borelli (alias Mutoli) even earlier (1664). Dörfel, who had been a pupil of Hevelius, arrived by a more legitimate path at the same conclusion as his master, by applying a geometrical discussion to the observed places of the great comet of 1680. But this work, whatever its merit, came too late to have any real importance. Astronomy was already on the brink of its most momentous epoch, and the true solution of the problem was now so near at hand, and as we now know so inevitable, that more or less fumbling guesses lose their interest. The law of cometary motion was never discovered in the sense that Kepler discovered the laws of planetary motion. The knowledge came simply as a by-product of Newton's work on gravitation.

Towards the end of the year 1680 the comet already mentioned was discovered by Gottfried Kirch at Coburg in Saxony. Few observed it before it reached perihelion; afterwards there were as many observers as astronomers living[2]. This was the comet observed and discussed by Dörfel, a pastor at Plauen in Saxony, in a work which has become exceedingly rare and inaccessible. It was also observed by Newton, and thus helped to revive in him an interest in astronomy which had been dormant for many years. But Newton's experience was not altogether happy, as the following extract from a letter indicates.

---

* Halley Lecture delivered at the University of Oxford on May 25.

> Newton for Flamsteed (through Mr. Crompton).
> "Cambridge, Feb. 28, 1680.
>
> "I am further suspicious that the Comets of November and December which Mr. Flamsteed accounts one and the same comet were two different ones, and I find Cassini in a copy of a letter of his which Mr. Ellis shewed me is of my mind. . . ."

Of course, Flamsteed was right and Newton was wrong, though he erred in respectable company. But the sequel is important enough to warrant this quotation.

> Newton to Flamsteed.
> "Trinity College, Cambridge.
> "Sept. 19, 1685.
>
> "Sir,
>
> ". . . I have not yet computed the orbit of a comet, but am going about it, and taking that of 1680 into consideration, it seems very probable that those of November and December were the same comet . . ."

It was convenient to forget the letter of five years before, but fortunately we are not concerned with that aspect of the case. By this time the acid stimulus of Hooke and the urgency of Halley have done their work, and Newton had already made substantial progress in the preparation of the "Principia". But though the principles were established and the complete design no doubt formulated, the necessary details for calculating the orbit of a comet were clearly not worked out before the end of 1685.

The outcome of these hectic months in Newton's life is well known. In the "History of the Royal Society of London"[3] it appears thus:

> "1687. April 6, Dr. Gale, vice-president, in the chair.
>
> "After the minutes of the last meeting were read, the third book of Mr. Newton's treatise *De Systemate Mundi* was produced and presented to the Society. It contained the whole system of celestial motions, as well of the secondary as primary planets, with the theory of comets; which he illustrates by the example of the great comet of 1680–1, proving that, which appeared in the morning in the month of Nov. preceding, to have been the same comet, that was observed in Dec. and Jan. in the evening.
>
> "Dr. Gale reported that he had lately received a letter of thanks from the authors of the *Acta Eruditorum Lipsiensia* for the *History of Fishes* sent them as a present from the Society."

In view of the importance of the occasion, the stress laid on a detail in cometary history may seem exaggerated, but is nevertheless significant. Similarly, there is a reason for repeating another single item from the minutes of the same meeting. The publication of the "History of Fishes" had gone far to deplete the funds of the Society and made it difficult to carry out another costly undertaking. How Halley stepped into the breach and took on himself the liability for the production of a work which owes so much to his encouragement for its existence is a familiar story. It is impossible to conjecture what the world would have lost if Halley had not lived. He had done more than anyone else to inspire the "Principia", he had kept an over-sensitive author to his task, and now he undertook its publication. The nature of a fourth service is still to be seen.

Several years passed, and Newton was within a year of leaving Cambridge, when more is heard on the subject of comets. The latest development can be given in Newton's words:

> Newton to Flamsteed.
> "Cambridge, Sept. 14, 1695.
>
> "Sir,
>
> "When I received your last, Mr. Halley was with me about a design for determining the orbs of some comets for me. He has since determined the orb of the comet of 1683 by my theory; and finds, by an exact calculus, that it answers all your observations and his own to a minute. . . ."

The reference is clearly to the comet of 1682, now known as Halley's, but the great man was ever a little careless about dates. This work on which Halley was already engaged only saw the light ten years later. His time was fully occupied. Between 1696 and 1698 he was deputy controller of the mint at Chester. In the four years after that he was almost continuously at sea in command of H.M. Pink, the *Paramour*, first in making the magnetic survey and then in charting the English Channel. Next year (1702) he made two voyages to the Adriatic, to advise a foreign Government on the fortification of Trieste. At last, in 1703, he became Savilian professor of geometry, in succession to Wallis, and could look forward to a time of comparative leisure. What he did was to finish the work on comets, and when that was published he produced in the following year the edition of Apollonius, for the purpose of which he had learnt Arabic. His activity at this period of his life was certainly amazing.

The paper[4], "Synopsis Astronomiæ Cometicæ", in which Halley communicated the results of his cometary researches to the Royal Society, is a model which can be commended to the attention of those authors who find that scientific societies are unwilling to grant all the space which they think is due to them. For this memoir, the importance of which has been universally recognized by laudatory epithets*, fills less than eighteen small quarto pages of fairly large type. There is a historical introduction (3 pp.). A single page contains the kernel of the whole, a table giving the parabolic elements of twenty-four comets; as Halley says, "Immensi pene Calculi fructum, exiguum quidem . . . munus." Then follows a kind of Barker's Table† (4 pp.) with a description and example of its use occupying about the same space. It can be inferred how much room was left for a discussion of the results.

In this paper purely parabolic motion is assumed throughout. The orbits are determined by Newton's methods. Whatever was not to be found or not understood in the "Principia" would naturally be supplied by Newton, for the two men were in close contact in this work, as the letter of 1695 shows.

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* For example, "epochemachend" (Mädler); "ces travaux si brillants et si neufs" (Delambre).

† The original Barker's Table was first published in 1757.

There has never been any dispute about their shares in the result, not need there be. Newton provided the methods, which from a practical point of view left ample room for improvement*, and Halley did the work of calculation.

PARABOLIC ELEMENTS OF 24 COMETS. HALLEY

Date of Perihelion Passage	Ascending Node	Inclination	Motion	Perihelion Longitude	Perihelion Distance
1337 June 2 6 25	84° 21′ 0″	32° 11′ 0″	R	37° 59′ 0″	0·40666
1472 Feb. 28 22 23	281 46 20	5 20 0	R	45 33 30	0·54273
1531 Aug. 24 21 18	**49 25 0**	**17 56 0**	**R**	**301 39 0**	**0·56700**
1532 Oct. 19 22 12	80 27 0	32 36 0	D	111 7 0	0·50910
1556 April 21 20 3	175 42 0	32 6 30	D	278 50 0	0·46390
1577 Oct. 26 18 45	25 52 0	74 32 45	R	129 22 0	0·18342
1580 Nov. 28 15 0	18 57 20	64 40 0	D	109 5 50	0·59628
1585 Sept. 27 19 20	37 42 30	6 4 0	D	8 51 0	1·09358
1590 Jan. 29 3 45	165 30 40	29 40 40	R	216 54 30	0·57661
1596 July 31 19 55	312 12 30	55 12 0	R	228 16 0	0·51293
1607 Oct. 16 3 50	**50 21 0**	**17 2 0**	**R**	**302 16 0**	**0·58680**
1618 Oct. 29 12 23	76 1 0	37 34 0	D	2 14 0	0·37975
1652 Nov. 2 15 40	88 10 0	79 28 0	D	28 18 40	0·84750
1661 Jan. 16 23 41	82 30 30	32 35 50	D	115 58 40	0·44851
1664 Nov. 24 11 52	81 14 0	21 18 30	R	130 41 25	1·02575$_5$
1665 April 14 5 15	228 2 0	76 5 0	R	71 54 30	0·10649
1672 Feb. 20 8 37	297 30 30	83 22 10	D	46 59 30	0·69739
1677 April 26 0 37	236 49 10	79 3 15	R	137 37 5	0·28059
1680 Dec. 8 0 6	272 2 0	60 56 0	D	262 39 30	0·00612$_5$
1682 Sept. 4 7 39	**51 16 30**	**17 56 0**	**R**	**302 52 45**	**0·58328**
1683 July 3 2 50	173 23 0	83 11 0	R	85 29 30	0·56020
1684 May 29 10 16	268 15 0	65 48 40	D	238 52 0	0·96015
1686 Sept. 6 14 33	350 34 40	31 21 40	D	77 0 30	0·32500
1698 Oct. 8 16 57	267 44 15	11 46 0	R	270 51 15	0·69129

A glance at the table of parabolic elements, which is reproduced here in a slightly modified form (in the original the longitudes are naturally expressed in the conventional Zodiacal signs), is enough to show the main result. The orbits found for the comets in the years 1531, 1607 and 1682 are strikingly similar. For this fact there are two possible explanations. Either three different comets follow the same path at nearly equal intervals of time (seventy-six or seventy-five years), or else it is one and the same comet describing an elongated elliptic orbit which would differ little from a parabola in the neighbourhood of the sun. Between these alternatives the question must have been one of probability. More recently, groups of comets with similar orbits have been found. But when the whole number of known orbits is no more than a couple of dozen and the difference in period is only a year, the choice looks simple. Still there is that difference, and therefore there is an element of risk. The reason for it Halley quite rightly attributed to the disturbing influence of the planets.

When the paper was reproduced with additions ten years after the author's death in 1742, in "Dr. Halley's Astronomical Tables", more confidence is shown in the identity of the three comets. Motion in a highly eccentric ellipse has been investigated. The mean distance assigned is $a=17{\cdot}8635$, the eccentricity (in Halley's sense) is $ae=17{\cdot}2810$, and therefore the eccentricity (in our sense) is $e=0{\cdot}9672$, a figure which does in fact lie between the osculating values in 1607 and 1682. Changes in the inclination and in the positions of the node and perihelion are unimportant because the observations of Apian in 1531 and Kepler in 1607 are too rough for any certainty, but the effect of perturbations is pointed out. Halley could not calculate the effect of perturbations on the period with any accuracy, but he estimated the influence of Jupiter fairly shrewdly. For he predicts the next return "circa finem anni 1758 vel initium proximi", and in the circumstances this is a very good approach to March 1759, the actual date.

It is only in this second version (1752) that two noteworthy passages occur. The first, which is famous, runs:

"Quocirca si secundum prædicta nostra redierit iterum circa annum 1758, hoc primum ab Homine Anglo inventum fuisse non inficiabitur æqua Posteritas".

The second is a challenge, resounding at the time† when it was written:

"Experiantur itaq., *Vorticum et Pleni absoluti* fautores, an juxta Hypotheses suas poterint hujus Cometæ, per novem integra Signa ac spatium plusquam quadrimestre visi, cursum repræsentare; et an alia Curva, aliave in eâ motus lex a nostra sensibiliter diversa, singularem Viæ ejus Curvaturam, ac Velocitates diversimode auctas ac minutas pari certitudine poterit exhibere. Si hoc fieri nequeat, discant tandem missis nugis Veritatis studio indulgere, et cum Regali Societate nostrâ *Nullius in verba* jurare."

The date predicted by Halley for the first return of the Comet after 1682 was necessarily vague. If perihelion passage about mid-December 1758 be inferred from his language, that would be about three months too early. Since he considered only the effect of Jupiter, and had no means of calculating these perturbations accurately, the result must be considered quite a good one. The subsequent history of the Comet affords an excellent illustration of the development of methods for calculating special perturbations with increasing accuracy.

The calculation of the first return in 1759 was not left to the rough prediction of Halley. In the rising school of French mathematicians who were destined to exploit the work of Newton, Clairaut (1713–1765) was the first to distinguish himself by researches on the figure of the earth, planetary perturbations and the lunar theory. On the instigation of Lalande he undertook to calculate the perturbations of the Comet, making it a condition that he should have the help of Mme. Lepaute (née de la Brière) as computer. Clairaut devised the methods to be used in the then novel task, and with this aid finished the necessary calculations in eighteen months, so that he could announce the result before the end of 1758. The predicted time of perihelion was April 13 in the following year, thus overshooting the mark by a whole month, for the actual date was March 12. There was nothing surprising in the discrepancy, because the masses of the planets were very imperfectly known. An error in the assumed mass of Saturn was chiefly responsible, and neither Uranus nor Neptune was so much as known to exist. The outcome of the pioneer research of this kind must be considered entirely successful.

Once more the Comet has started on its long journey. Before it returns, mathematical astronomy will have made great strides. Euler will not see it again: he is too nearly the contemporary of Clairaut. Neither will Lagrange, nor Laplace. But all these and others will have enriched science by their immortal labours, and there are many to hand on the torch. No fewer than four astronomers undertook the task of calculating the perturbations on this occasion, of whom one carried them back as far as 1607. For the date of perihelion in 1835 the results were: Damoiseau, November 4; Rosenberger, November 11; Pontécoulant, November 13; Lehmann, November 26. This time, thanks to the last shot (which is the most discordant), the target is bracketed. For the date actually assigned after the event was November 15, 1835. Rosenberger's seems to have been the most careful investigation entering into competition, and his predicted date is four days too early. It will be noted that since the last return Uranus has been added to the known list of planets, but Neptune still awaits discovery.

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* "Newton ne nous a donné que des solutions imparfaites sur les comètes" (Lagrange).

† "The Synopsis of the Astronomy of Comets was printed off at the same time as the Tables" (Preface). This presumably means 1719, and the date of the manuscript was not later than 1717.

Before the Comet returns again, astronomy has enjoyed another period of orderly development. Thanks to Adams and Leverrier, Neptune has been included in the number of the planets, and under photographic scrutiny it seems unlikely that any other of comparable mass remains to be found. Thanks again to Leverrier and later to Newcomb, the masses of all the planets are now known with greater accuracy than before. A technical advance has been made in presenting the tabular co-ordinates of the disturbing bodies and the principles being recognized, in the calculation of special perturbations there is room for little more than a judicious choice in the management of the details. Thus the conditions for a close prediction in 1910 were favourable.

It is tempting to make one remark. The methods of science, once devised, cannot be controlled in their application. Thus the method of special perturbations, which follows the disturbed body in its motion step by step, is a form of interpolation, a method of which Newton himself was a master. But, being quite general in its character, it is essentially the same method as that employed in calculating the trajectory of a shell by small arcs, and hence the range table of a gun. It is therefore the same mathematical process which predicts the return of a comet or the course of a minor planet for the peaceful astronomer as that which gives land or naval artillery its deadly effect. This is an illustration of the simple and inescapable fact that science in itself is amoral.

In spite of the technical simplifications of which the process is capable, the task of calculating special perturbations over the three-quarters of a century (or rather over a century and a half, for two circuits of the course before 1910 were in fact followed, to ensure accuracy) is still laborious in the extreme. In this case the Lindemann Prize offered by the Astronomische Gesellschaft attracted only two competing essays, and there was no difficulty in deciding between them since one proved to assign a date two months later than the time of perihelion deduced from observation.

The successful essay was the joint work of Messrs. Cowell and Crommelin, assisted by several volunteer computers. Their date for the perihelion passage in 1910 was April 16·6. The comet was first recognized on a photograph by Dr. Max Wolf on September 11, 1909, and on March 5, 1910, the two English astronomers felt justified in stating:

> "It now appears from the observations that the predicted time [April 16·61] is 3·03 days too early. At least two days of this error must be attributed to causes other than errors of calculation or errors in the adopted positions and masses of the planets."

This very precise statement indicates that the problem of Halley's Comet has not been completely solved and ensures that the return in 1986 will receive careful attention. As in 1835 according to Rosenberger, so in 1910 the Comet reached its closest approach to the sun too late to agree with theory. As all questions of the physical nature of comets are now left to be discussed by some future Halley lecturer, this is one which needs more evidence before it can be discussed profitably. The discrepancy is of the wrong sign to be explained by the resisting medium invoked to account for the anomalous motion of Encke's Comet. On the other hand, while motions in almost parabolic orbits have had their value for the theory of gravitation, the constitution of a comet is far removed from the ideal particle which the mathematician would choose as a test. The nucleus of Halley's Comet transited the sun on May 18, 1910. By no means whatever could any certain effect be observed. Similarly, in the middle of May the earth may have passed through the tail of the comet. Whether it did so or not, no effect was to be anticipated, and certainly none was seen.

From the moment that the periodic orbit of the Comet is assured, it becomes possible to trace its course forward or backward with equal facility—or the same irksome toil. Now bright comets have appeared in the past and not a few of them have gained historical notoriety. It is therefore a question of great interest to identify such comets when possible with past appearances of Halley's Comet.

Halley himself was the first to make the attempt. The comets of 1531, 1607 and 1682 gave him intervals of 76 and 75 years. On this evidence alone a great comet should have appeared about the year 1456. It happens that a comet seen that summer, when the Turks were threatening to overrun Europe, is one of the most famous historically in the whole series. The identification in this case has proved sound. But the mean period over two milleniums is not far short of seventy-seven years, and therefore when Halley tried to go back further (to 1380 and 1305) he made errors of two and four years, and would have been led further astray if he had not stopped at that point. The method was too crude for anything more than a short-dated suggestion. The date 1456 was confirmed by Pingré (1711–1796) on the more legitimate evidence of an orbit deduced from observations.

The next identification was made by Burckhardt (1773–1825) with a comet observed in 989. Though recorded in the Saxon Chronicles, it was also observed in China, and the Chinese observations made it possible to determine an orbit.

This recognition of an isolated return illustrates the fact that the most trustworthy data before the fifteenth century are to be found in the Chinese annals. Three appearances of Halley's Comet were thus identified by Laugier (1812–1872), an astronomer of the Paris Observatory. These occurred in 451 (coinciding with the Battle of Chalons), 760 and 1378.

But the most extensive research of this kind was made by J. R. Hind (1823–1895), who, like Dr. Cowell, was later to become superintendent of the "Nautical Almanac". His work covered all the appearances of the present era from 12 B.C. onwards, and though three or four have not been substantiated, a round dozen of true identifications remain to his credit. Where he failed, the cause is simple: the Chinese observations were insufficient to establish the orbit with the necessary precision. When the

Chinese record of the Comet's return gave adequate detail, Hind was right, and Dr. Crommelin has testified to the value of his work as a foundation for subsequent research.

Thus a few doubtful cases remained, as Hind himself indicated, and to decide them a much more laborious method was required. It was necessary to trace the Comet back through the centuries by tracing its perturbations continuously. This looked like a Herculean task, and it was in fact arduous enough. But Dr. Cowell devised a notable simplification in the method and the late Dr. Crommelin and his collaborators carried out the work. Not all the refinements necessary when prediction within a few hours is aimed at are needed in this backward sweep, but no means for securing essential accuracy were neglected.

RETURNS TO PERIHELION

(Cowell and Crommelin)

240	(B.C.)	May 15 ?	912	(A.D.)	July 19
163	,,	May 20 ?	989	,,	Sept. 2 (Burckhardt)
87	,,	Aug. 15	1066	,,	Mar. 25 (Hind)
12	,,	Oct. 8 (Hind)	1145	,,	April 19 (Hind)
66	(A.D.)	Jan. 26 (Hind)	1222	,,	Sept. 10
141	,,	Mar. 25 (Hind)	1301	,,	Oct. 23 (Hind)
218	,,	April 6 (Hind)	1378	,,	Nov. 8 (Laugier)
295	,,	April 7 (Hind)	1456	,,	June 2 (Halley, Pingré)
374	,,	Feb. 13 (Hind)	1531	,,	Aug. 25 Halley
451	,,	July 3 (Laugier)	1607	,,	Oct. 26
530	,,	Nov. 15 (Hind)	1682	,,	Sept. 14
607	,,	Mar. 26	1759	,,	Mar. 12
684	,,	Nov. 26 (Hind)	1835	,,	Nov. 15
760	,,	June 10 (Laugier)	1910	,,	April 19
837	,,	Feb. 25 (Hind ?)	1986	,,	Feb. ?

The result is the accompanying table, which records the times of perihelion passage over a period of two thousand years, the outcome of an investigation which is a model of its kind. With the dates are given the names of the astronomers who first identified the return with a recorded comet.

Before A.D. 1400 the identifications rest mainly on Chinese observations, as already remarked. That does not mean, of course, that the Comet was not mentioned in European annals, but merely that the European descriptions have little astronomical value. On the contrary, the Comet has blazed its trail through the pages of Western history, as in 1066, and the historian may find great interest in a list of dates which, thanks to the labours of Cowell and Crommelin, he may accept as perfectly trustworthy.

When the central problem of astronomy is considered, and the importance of Halley's Comet in relation to that problem, one thing must be understood. The history of science is no mere catalogue of ideas and discoveries. It is not enough to separate the true from the false so far as that can be done at a given time, but it is also necessary to see how the truth came to be established and how error was finally overcome. In general, the process has been slower than is commonly realized. Even in our time, when development is continuous and is watched by a thousand eyes, we have seen eminent chemists reluctant to abandon their indestructible atom and accept the electron theory of matter. It is altogether wholesome that novel assertions should meet with critical reserve.

Very different was it in the ages when science progressed by fits and starts. Thus Aristarchus of Samos, the contemporary of Archimedes, proclaimed the heliocentric theory of the solar system. Eighteen centuries elapsed before the truth of the idea was recognized by Copernicus. It is sometimes implied that this was an independent discovery. But the origin of the idea was immediately pointed out by commentators in England, and it could not have escaped Copernicus himself, who had studied in Italy and elsewhere, and was a quite exceptionally well-educated man. His merit consists in reconciling the idea with the Ptolemaic theory. But as there was nothing to prevent anyone from doing the same thing at any time during the preceding fourteen centuries, he must be held to have written a belated last chapter of the old astronomy, not a first chapter of the new. Apart from what was due to Aristarchus, the errors of Ptolemy were perpetuated.

The new order in astronomy came in 1609 with the "Astronomia Nova" of Kepler. It was the result of studying new, prolonged and more accurate observations. For the first time in a work of this kind, the proportion of truth is greater than the proportion of error. It gave a sound foundation for further progress. But how slowly was its true character recognized, even in an age which was beginning to move rapidly.

There was one notable, though unproductive, exception. It is shown in that remarkable letter addressed by Sir William Löwer from the neighbourhood of Caermarthen to Thomas Harriot at Sion House. A few sentences from it may be given:

"February 6, 1610.

"I have received the perspective Cylinder that you promised me. . . . According as you wished I have observed the Mone in all his changes. . . .

"Kepler I read diligentlie. . . . Not of his causes for I cannot phansie those magnetical natures, but about his theorie which me thinks (although I cannot yet overmaster manie of his particulars) he establisheth soundlie and as you say overthrows the circular Astronomie.

"Do you not here startle, to see every day some of your inventions taken from you; for I remember long since you told me as much, that the motions of the planets were not perfect circles. . . .

"But again to Kepler I have read him twice over cursoridlie, I read him now with Calculation. Sometimes I find a difference of minutes. . . . For this theorie I am much in love with these particulars.

"1° his permutation of the medial to the apparent motions, for it is more rational that all dimensions as of Eccentricities, apogacies, etc. . . . should depend rather of the habitude of the sun, than to the imaginarie circle of orbis annuus.

"2°. His elliptical iter planetarum, for methinks it shews a Way to the solving of the unknown walks of comets. For as his Ellipsis in the Earth's motion is more a circle[*] and in Mars is more longe and some of the other planets may be longer againe, so in thos comets that are appeard fixed the ellipsis may be neere a right line.

"3°. His phansie of ecliptica media or his via regia of the sun, even the ecliptica vera under w^{ch} the earth walkes his yeares journie; by w^{ch} he solves handsomelie the mutation of the starres latitudes. Indeed I am much delighted with his booke, but he is so tough in manie places as I cannot bite him. . . .

". . . Above al things take care of your health, keepe correspondence with Kepler and whereinsoever you can have use of me, require it with all libertie. . . .

"WILLM. LÖWER."

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[*] What precedes this point is from a paper at Petworth House, found and reproduced by the Baron von Zach. The continuation is in the British Museum. The whole was reconstituted by Rigaud and printed in the supplement to Bradley's works. It is also to be found in Henry Stevens's "Thomas Hariot, Mathematician, Philosopher and Scholar" (London, 1904).

Three things are notable in this letter of a Welsh squire, drawing his inspiration from Harriot. First, there is the early specific mention of the use of a telescope in England. Then there is the suggestion as to the nature of cometary orbits, which is in line with, and much earlier than, Borelli's. It is to be remembered that both Harriot and Löwer observed Halley's Comet in 1607. Finally, the appreciation of Kepler and the implied criticism of Copernicus are extraordinarily acute. Such insight is nowhere to be found outside the circle of Harriot.

Why the message of Kepler fell on deaf ears elsewhere is an interesting problem. But two of the evil influences can be seen. The first—and this will surprise many who have imbibed a legend without due qualification—was Copernicus and his school. This great man had served as a useful link with the past. From the beginning of the following century the effect of his doctrines was simply mischievous. This remark can be easily illustrated.

When Horrocks started on his brief career as an observer, he sought the advice of Gellibrand, the Gresham professor of astronomy. On this recommendation he procured the works, including the Tables, of Lansberg. Comparison with his own observations soon convinced him that Lansberg was wrong in theory, wrong in everything. His denunciation of Lansberg was unsparing. Then he turned to Kepler, and in spite of the admitted faults of the Rudolfine Tables quickly came to the conclusion that he who has Kepler has everything. The tables were based on faulty numbers and these could be corrected by his own observations. But Lansberg's, being based on faulty theory, were hopelessly wrong. Now Lansberg was just an orthodox Copernican living in the wrong century; the real cause which excited the wrath and contempt of Horrocks was the Copernican doctrine, which had grown completely out of date. The work in which he champions Kepler was published thirty years after it was written, and it may have failed to have its due effect. But it is significant that all those discussions of Keplerian problems between Hooke, Wren and Halley which preceded the composition of the "Principia" were subsequent to the year 1672, when the "Opera Posthuma" of Horrocks was at last published by Wallis and warmly commended by James Gregory and by Newton.

Meanwhile Galileo had lived and died, and was destined, thanks to a few simple experiments in dynamics, to transform the thought and the physical condition of mankind. But his attitude to the problem of planetary motion is generally misrepresented. Like Harriot, he received a copy of Kepler's "Astronomia Nova", but there is not the slightest sign that he ever read it. He was not an ardent mathematician and without a Harriot at his back he was less likely to 'bite' such a book than our worthy Löwer. It is equally unlikely that he had any taste for the Ptolemaic details of Copernicus. His heliocentric theory was the simple doctrine of Aristarchus, founded on the argument from analogy which he drew from the Jovian system of satellites. As such it would be noticed as the view of a remarkable man of that age, but nothing more. That it has come to be otherwise regarded is due to quite adventitious causes, which have at the same time floated Copernicus on a tide of popular fame. These causes are the events of 1616 in the life of Galileo, the placing of the "De Revolutionibus" on the Index in the same year, and the subsequent persecution of Galileo in his declining years. But for these events, which have tended to overshadow the infinitely greater merits of Kepler, it is extremely probable that the general estimate placed on Copernicus would be slightly different from what it is to-day. Even at the time, the incidents did nothing to promote sound scientific opinion.

Altogether, astronomical opinion in the first half of the seventeenth century was in a state of great confusion. The Copernican theory still had its ardent supporters, but its radical unsoundness became more and more apparent. Instead of stimulating fresh efforts to find a better theory and to examine Kepler, as it did in the end with Horrocks, the failure induced a general feeling of futility and despair. The true system of astronomy seemed to be unattainable. On the other hand, those who had persecuted Galileo came to see that they had won a Pyrrhic victory and were ready to tolerate any theory so long as it was not called Copernican. The ground was therefore ready for a new crop, and while the good seed of Kepler was only waiting to be planted and nurtured by the hand of the mathematician, the second evil influence appeared and prepared a harvest which may have served to supersede the lingering remnants of Copernicanism, its chief recommendation in many eyes, but otherwise was worse than useless. This was the Cartesian system of philosophy.

René Des Cartes (1596–1650) spent the last twenty years or more of his life in Holland, latterly in Leyden. His chief works were two, the "Discours de la Méthode" (1637–8) and the "Principia Philosophiæ" (1644). The solid reputation of the author rests on one of three appendixes to the first. This contains his work on geometry, wherein co-ordinates are treated by algebraic methods; this is original and it marks an epoch in mathematics. Another is a treatise on optics and contains Snell's law of refraction, until then unpublished but certainly known sixteen years earlier. The science of optics, physical optics in particular, was then in a primitive state and Des Cartes did little to improve it. His later work contains his ideas on the laws of motion and his theory of vortices as a cosmic principle. To put it bluntly, this theory is trash, and it is hard to treat seriously a philosophy from which it sprang. Yet in its day, which lasted for a century, it enjoyed extraordinary popularity not only among the ignorant but also among those who would naturally be assumed to know better. Huygens, the greatest physicist of the seventeenth century, Newton not excepted, was a typical and at the same time an exceptional case. Des Cartes was an intimate personal friend of his father, Constantijn Huygens, and Christiaan was nurtured on the pure Cartesian doctrine. He remained a Cartesian through life, though this did not prevent him from correcting Des Cartes on the laws of motion or developing his own science in his own original way. But the Cartesian prejudices remained with him to the end. In England the bigger men seem to have escaped the influence tolerably well, though there was a moment when, according to Whiston, the doctrine had gained a firm hold on the teaching at Cambridge. In France the attack was most severe and lasted well into the eighteenth century in academic circles. The reason is easily conjectured. The doctrine of vortices was designed as an escape from Copernicanism to satisfy orthodox Catholic prejudices, and was therefore popular in the France of Louis XIV; besides, it was the work of a Frenchman. This explanation does not apply to the special case of Huygens, who was a Dutch Protestant, and of course the case of England is quite different. Another illustration of this line of thought is to be seen in the readiness of Voltaire to follow Newton.

It is sometimes too readily supposed that Newton's "Principia" met with immediate acceptance. Newton's reputation as a mathematician was great and had spread far beyond the limits of England. The book was recognized as a remarkable work in the limited circle of men who could read it intelligently. But if anyone thinks that its doctrines and its spirit was accepted even by the most competent judges of the time, he should read the letters which passed between Leibniz and Huygens. A few specimens may be quoted.

The first extract shows the eagerness of Huygens to see the "Principia", though he cannot conceal his Cartesian predilections. In the second, Huygens gives Leibniz excellent advice and seems to show signs of conversion; "besides, you know, these vortices are not without their difficulties". Then in the third he swings completely round: "Newton's principle of attraction seems to me absurd". Finally there is a fair sample of the obstinacy with which Leibniz clings to his Cartesian ideas. Let it be observed that, throughout, neither Huygens, the physicist who had first seen Saturn's ring with an understanding eye, nor Leibniz, the mathematician and philosopher, betrays the slightest sense of the needs of practical astronomy. The astronomer wants the "Nautical Almanac", and naturally has little patience with the philosopher who is so imprudent as to stand in the way of that legitimate object.

(*a*) Huygens to Fatio de Duillier (extract).
1687, July 1/11.

"Je souhaite de voir le livre de Newton. Je veux bien qu'il ne soit pas Cartesien pourveu qu'il ne nous fasse pas de suppositions comme celle de l'attraction.

"Cela me paroit assez étrange que les rayons employent un temps egal et qu'il ait pourtant un autre principe. La proposition du Globe assez paradoxe j'en voudrois voir la demonstration. . . .

"Mes respects a M. Boyle. Ayons le livre de Newton". ("Œuvres Complètes de Christiaan Huygens", 9, 190.)

(*b*) Huygens to Leibniz (extract).
Jan. 30.
1690, Feb. 9.

". . . Je vois que vous vous estes encore rencontré avec luy en ce qui regarde la cause naturelle des chemins Elliptiques des Planetes mais comme en traitant cette matière vous n'aviez encore vû qu'un extrait de son livre et non pas le livre mesme, je voudrois bien sçavoir si du depuis vous n'avez rien changé à vostre Theorie, parce que vous y faites entrer les Tourbillons de Mr. des Cartes, qui à mon avis sont superflus, si on admet le Systeme de Mr. Newton où le mouvement des Planetes s'explique par la pesanteur vers le Soleil et la *vis centrifuga*, qui se contrebalancent. Outre que ces Tourbillons Cartesiens faisoient naitre plusieurs difficultés, comme vous verrez par mes remarques et mesme sans elles vous ne pouviez pas l'ignorer. . . ." (Œuvres Complètes, 9, 366.)

(*c*) Huygens to Leibniz (extract).
1690, Nov. 8/18.

"Pour ce qui est de la Cause du Reflus que donne M. Newton, je ne m'en contente nullement, ni de toutes ses autres Theories qu'il bastit sur son Principe d'attraction, qui me paroit absurde, ainsi que je l'ay desia temoigné dans l'Addition au Discours de la Pesanteur. Et je me suis souvent etonné, comment il s'est pu donner la peine de faire tant de recherches et de calculs difficiles, qui n'ont pour fondement que ce mesme principe. Je m'accomode beaucoup mieux de son Explication des Cometes et de leur queues; et quoyque la chose ne soit pas sans cette grande difficultè, que vous remarquez fort bien, je ne trouve encore rien de meilleur que ce qu'il en dit, qui vaut mieux incomparablement, que ce qu'en a imaginé des Cartes. . . ." (Œuvres Complètes, 9, 536.)

(*d*) Leibniz to Huygens (extract).
1692, Sept. 16/26.

". . . Il faudra examiner quelle explication est la meilleure, ou si on les peut concilier. Le même se peut dire à l'égard de l'explication de Mons. Neuton des ellipses. Les Planetes se meuvent comme s'il n'y avoit qu'un mouvement de trajection ou de propre direction joint à la pesanteur à ce que Mons. Neuton a remarqué. Cependant ils se meuvent aussi, tout comme s'ils estoient deferés tranquillement par une matière dont la circulation y soit harmonique; et il semble qu'il y a une conspiration de cette circulation avec la propre direction de la Planete. Et la raison qui fait que je ne me repens pas encor de la matière deferente, depuis que j'ay appris l'explication de Mr. Neuton, est entre autres, que je voy toutes les Planetes aller à peu près d'un même costé, et dans une même region, ce qui se remarque encor à l'égard des petites Planetes de Jupiter et de Saturne. Au lieu que sans la matière deferante commune rien n'empescheroit les Planetes d'aller en tous sens. . . ."
(Œuvres Complètes, 10, 316.)

The views of Locke and Leibniz make an interesting contrast. Thus Locke:

"It is true, I say, 'that bodies operate by impulse, and nothing else.' And so I thought when I writ it, and can yet conceive no other way of their operation. But I am since convinced by the judicious Mr. Newton's incomparable book, that it is too bold a presumption to limit God's power, in this point, by my narrow conceptions. The gravitation of matter towards matter, by ways inconceivable to me, is not only a demonstration that God can, if he pleases, put into bodies powers and ways of operation, above what can be derived from our idea of body or can be explained by what we know of matter, but also an unquestionable and everywhere visible instance, that he has done so." ("Essay", p. 408, 1699.)

Locke also remarked that nothing is more likely to assist the sceptics than to deny what we do not understand. In his "New Essays" (1700, pub. 1765) Leibniz replies: "I fully recognize that it is not allowable to deny what we do not understand, but I add that we have the right to deny (in the order of nature at least) what is absolutely unintelligible and inexplicable."

After that exhibition of considerable egotism, is it strange that science should find in seventeenth century philosophy, the philosophy of Des Cartes, Malebranche, Spinoza and Leibniz, with all their differences, nothing much better than an obstructive irrelevancy? That is what Newton found it in the criticism of his theory of colours, and it is to be seen again in the reception accorded to the "Principia". Though the fact has been overlooked, the feeling engendered at the time will help to explain the venom which entered into the controversy over the development of the infinitesimal calculus. In his last shaft, Leibniz virtually accuses Newton of atheism, than which at the time no insinuation could be more injurious. In liberality (and perhaps in clearness) of thought the lapse of a century shows remarkably little advance on the Inquisition which condemned Galileo.

Now all this seems very far removed from the story of Halley's Comet. The object has been to show by examples drawn from the history of astronomy that the acceptance of new and sound ideas is in general slow, and that the reception of Newton's "Principia" was no exception to the rule. It remains to be seen what bearing Halley's work on comets had on the outcome.

It has already been shown, and it is generally appreciated, that Halley's share in the production of the "Principia" was a considerable and quite possibly a vital one. In the first place, he directed Newton's attention with persuasive urgency to the great problem of astronomy. But when Newton's interest had been definitely engaged in the desired direction, circumstances arose which in a man of such delicate susceptibilities might easily have turned him from the completion of his task. Halley intervened and smoothed away the difficulties as they arose. At last the work was finished and safely delivered to the Royal Society. The Society was willing and eager to publish it, but at the moment it lacked the means. Halley, then a poor man, came forward and undertook the financial responsibility. But Halley also rendered a fourth service, and the nature of this is still to be seen.

The miracle of the "Principia" lies in its comprehensiveness. At the beginning Newton had perhaps a few fundamental theories, but even of these it was necessary to recover the proofs. From this point, within a period of barely two years, he has covered the whole field of gravitational astronomy, and that in considerable detail. The first steps have been taken in the lunar theory, the most difficult part and the one which ultimately supplies the most delicate test of the whole. Nutation* has been discussed, even before its discovery from observations by Bradley. The theory of tides has been developed; the attitude of Huygens to it has been noticed incidentally. A later event may also be noted. In 1740 the Paris Academy of Sciences proposed the subject of tides for competition. The three memoirs submitted respectively by Euler, by Maclaurin and by Daniel Bernoulli are all based on Newtonian principles. Yet even at so late a date as this there was a fourth which still maintained the Cartesian doctrine and commanded respect. The pleasantest aspect of this affair was the contribution of Daniel Bernoulli, for he was the son of John who, during the controversy over the "Commercium Epistolicum" was currying favour with Newton and at the same time stabbling him in the back, and the nephew of James, who in spite of his great gifts had strange ideas about comets.

But in spite of all those things in the "Principia" which excite wonder to-day, recognition of its fundamental truth was slow in coming. Nor is this altogether surprising, because it had to wait for that confirmation which rests on the comparison of its rapidly sketched theory with the result of accurate observations. This ultimate test came in time, and in spite of small discrepancies still outstanding, the main position is no longer in dispute. But this is a result of slow growth. First Bradley introduced a new order of accuracy into the observations. Then the theory of the planets was developed. But even after a century or more, even to-day, though the margin of uncertainty grows smaller, the normal difference between observation and calculation can rarely be traced to its source with perfect assurance. There is the error inherent in the observation. There is error in the system of numerical data adopted. There is possible error and always incompleteness in the practical development of the theory. There is the possibility of unknown and unsuspected disturbing influences of an alien kind. All these must be taken into account and assessed before judgment can be passed on the adequacy or failure of the general law of gravitation.

Therefore it is not surprising that at a time when the technical state of astronomy was still backward, the sceptics could find plausible excuses for their attitude. What was wanted to overcome the opposition of the Cassinis, who were practical astronomers, and the Bernoullis, who were not, was an example, preferably qualitative and if possible spectacular, to serve as an advertisement of the new system. By his "Synopsis Astronomiae Cometicæ" Halley supplied this want. Comets had always been unruly and erratic members among the heavenly bodies. In Kepler's day, though he understood them very imperfectly, they had destroyed the lingering remnants of the planetary spheres. By reducing them to order according to Newtonian principles Halley smashed the last traces of the Cartesian vortices, which had never explained anything because they were themselves without explanation. Hence the importance of the challenge to the Cartesians already quoted, which shows that he realized clearly the significance of what he had done, though these barbed words were only published thirty-five years after they were written. By that time the issue was no longer in doubt. But one thing remained to be seen, though not by Halley: the return of the famous Comet. It was first detected on Christmas Day, 1758, when approaching the sun. How it passed on in ts appointed track has been related. With it as it went once more into obscurity went also the last remnants† of that type of natural philosophy which is associated with the names of Des Cartes and Leibniz. In hastening that day, Halley rendered his fourth great service alike to Newton and to science.

NOTE

There is an interesting passage in Whiston's memoirs[5]:

"I proceed now in my own history. After I had taken Holy Orders, I returned to the College, and went on with my own Studies there, particularly in Mathematicks, and the *Cartesian* Philosophy; which was alone in Vogue with us at that Time. But it was not long before I, with immense Pains, but no Assistance, set myself with the utmost Zeal to the Study of Sir *Isaac Newton's* wonderful Discoveries in his *Philosophiæ Naturalis Principia Mathematica*, one or two of which Lectures I had heard him read in the publick Schools, though I understood them not at all at that Time. . . . We at *Cambridge*, poor Wretches, were ignominiously studying the fictitious Hypotheses of the *Cartesian*, which Sir *Isaac Newton* had also himself done formerly, as I have heard him say. What the Occasion of Sir *Isaac Newton's* leaving the *Cartesian* Philosophy, and of discovering his amazing Theory of Gravity was, I have heard him long ago, soon after my first Acquaintance with him, which was 1694, thus relate, . . ."

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* It must be allowed that Newton's nutation and Bradley's are not quite the same thing.

† Fontenelle, reputed the last Cartesian of any scientific standing, had died in 1757, thirty-three days short of his hundredth birthday.

Then follows an account of incidents during Newton's life at Woolsthorpe when he retired from Cambridge owing to the plague. Doubt has been cast on some details of this story. But it is corroborated in all essentials not only by Pemberton but also by an account left by Newton himself. There can be no doubt that it represents a story which Newton was rather fond of telling in his old age. If therefore any doubt is to be entertained as to its accuracy, that must be attributed to the failing memory of an old man. It does not seem impossible that some picturesque details have accrued in the course of years.

That is not the present point of interest. If according to this account Newton ever flirted with the Cartesian philosophy, that must have been during his undergraduate days. That at some time Newton must have studied "the fictitious Hypotheses of the Cartesian" is one of Whiston's essays in the obvious. As the protagonist of a system of natural philosophy which found its greatest obstacle in the hypotheses of Des Cartes, Newton could scarcely have failed to do so. But the attitude of complete antagonism was established at least as early as 1666 (*aet.* 23).

But Whiston was twenty-five years younger than Newton, whom he succeeded in the Lucasian chair at Cambridge in 1703. The year in which he took deacon's orders was 1693. Thus the years of which he is speaking, when the Cartesian philosophy was alone in vogue at Cambridge, was at least six years after the publication of the "Principia", and not very long before Newton left Cambridge for London. It appears then that whatever impression the "Principia" may have created outside Cambridge, inside Cambridge the teaching of Newton had been practically without any effect whatever.

At no time had Newton a gift for friendship. But that in itself is no reason why he should not have enjoyed the active support of discerning men. This he had, from Halley in the greatest measure, but also from others. David Gregory (nephew of James), the Savilian professor of astronomy, adopted the Newtonian philosophy from the first. When the controversy with Leibniz assumed an unpleasant aspect, it was to John Keill, another Savilian professor, that Newton turned as his champion. Locke wrote: "I have several reasons to think him truly my friend". Now all these were Oxford men. Even Henry Pemberton, the editor of the third edition of the "Principia", was introduced to Newton by Keill; he was not a Cambridge man. Robert Boyle, another acquaintance in correspondence with Newton, was a member of the group of men living in Oxford who founded the Royal Society.

It is inevitable that a comparison should be made with Newton's environment at Cambridge. If Newton sought no friends, it would still be supposed that some men of parts would seek his intellectual acquaintance. There is little evidence of it. Barrow resigned the Lucasian professorship in favour of Newton in 1669, became Master of Trinity in 1673, and died in 1677. That must have been a great loss to Newton. Whiston (of Clare Hall) made his acquaintance as related by himself, and Bentley cultivated it too, but philosophy rather than science was the common bond. This was only a few years before Newton left Cambridge; when Bentley became Master of Trinity (1700), Newton was established in London. But Bentley's account of the state of the College proves that Newton must have found it an utterly uncongenial environment. The impact of the Restoration on an academic community had been disastrous. At the same time Whiston's evidence goes to show that Newton was out of sympathy with the general trend of thought in the University of Cambridge at large.

These circumstances seem to explain much; why, for example, Newton was so ready to leave his quiet academic seclusion for the crowded life of the metropolis. It is just possible that Trinity was not so very quiet, while London and the Royal Society offered intellectual society far more to his taste. There is another aspect of the matter. In spite of Bentley's reforming zeal, which did produce fruit in a notable band of scholars, such as Porson, Cambridge in the eighteenth century, and Oxford too for that matter, failed conspicuously to take advantage of the opportunities opened up by Newton. An excuse has often been found in the notation (or absence of notation) of the fluxional calculus when contrasted with the methods of Leibniz. This seems hard to believe. Had there been a school of mathematicians, of the calibre of Colin Maclaurin for example, it is impossible to conceive that a mere question of notation would have been allowed to remain an obstacle when the successes of Clairaut and Euler were fairly considered. They did not receive this consideration because the men capable of giving it did not exist. The best English mathematicians of the period, like Simpson, Hutton and Peter Barlow, who were all connected with the Military Academy at Woolwich, owed nothing to university education.

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[1] Cf. Zinner, E., "Leben und Wirken des Johannes Müller von Königsberg genannt Regiomontanus" (Munich, 1938).

[2] Pingré, "Annales Célestes du XVIIe Siècle", p. 359 (1901).

[3] Birch, "History of the Royal Society", 4 (1757).

[4] *Phil. Trans.*, No. 297, pp. 1882–99 (March, 1705).

[5] *Whiston's Memoirs*, 1, 35 (1749); Rouse Ball, "Essay on Principia" p. 8.

SOME BIOLOGICAL DISCOVERIES OF PRACTICAL IMPORTANCE*

By Dr. C. H. WADDINGTON

THERE are two main spheres in which biology is of practical importance to society. One is medicine in the widest sense, which it would perhaps be more accurate to call human biology, and the other is food production or agriculture, also in the widest sense.

I do not propose to discuss the first of these fields in any detail, although new discoveries and new applications of old discoveries are always being made. Among recent new discoveries one may perhaps mention the bacteriocidal and bacteriostatic substances which are now being obtained from lower organisms. Penicillin, extracted from a mould related to the ordinary bread mould, is being investigated at Oxford and elsewhere and seems likely to prove one of the most powerful aids in dealing with infected wounds, a matter of the greatest importance at the present time. It may, however, be rivalled by gramicidin, a substance prepared by American workers from certain types of bacteria which grow in soil; but perhaps the more optimistic view will prove justified and the two substances be found to attack rather different kinds of germs and thus to supplement each other. As an example of a new technique of utilizing old biological knowledge, one may mention the treatment of various diseases, chiefly cancer in some of its forms, by radioactive substances artificially prepared with the aid of new physical apparatus such as the cyclotron. Radiophosphorus and radio-iodine are differentially absorbed by different tissues in the body; their radioactivity causes the destruction of the tissues in which they become located and the surgeon can in this way bring about a localized inhibition of particular tissues which are proliferating too rapidly.

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* Substance of a lecture delivered at the Royal Institution on February 12.

But the great tasks of medicine in the immediate future are concerned with the application of knowledge which we already possess. These tasks can be summarized under three heads: first, the attainment in practice of optimal standards of nutrition, of housing, of industrial hygiene, and so on; secondly, the conquest of tropical diseases and the improvement of the health of tropical populations until they have an equal chance with the peoples of the temperate zones to play their part in world civilization; and thirdly, a task in which social biology must collaborate with political and other agencies, is the reversing of the general fall in the reproductive-rate in industrial countries. New discoveries may, and very probably will, be made which will assist in the carrying out of these tasks, but the main problems are certainly the administrative and political ones of applying existing knowledge.

When we turn to the field of food production we find a great body of existing knowledge which is in process of being put into practice. Such developments of farming practice as the system of ley-farming and the increased use of silage are examples. But there are also a number of biological discoveries which may have very revolutionary effects on the whole of our food production system, and it is primarily a summary of these more far-reaching possibilities that I propose to discuss.

We may mention first some new uses for old crops. Straw is bound to be produced in large quantities along with any cereal crop, but, except for some oat straws, it is itself of little value for feeding animals. It has recently been shown that a treatment with caustic alkali breaks down the hard tissues of the straw sufficiently to allow of its being digested by cattle, and a very considerable new source of feeding-stuffs has thus been placed at the farmer's disposal. A more striking innovation would be the direct use of grass protein for human consumption. Grass is much our biggest crop; we produce about 60 million tons a year. It is too full of indigestible fibre to be eaten by man in the raw state, and the methods by which we use it are still those which were invented in the Stone Age; we feed it to cattle and sheep and ourselves eat the beef, mutton, milk, etc., which they produce. They can, it is true, digest the fibres with which the human intestines cannot deal, but they are relatively inefficient in making use of the proteins. Now it is comparatively easy to grind up the grass and squeeze out some 30 per cent of the protein for our direct use. The remainder of the protein remains with the fibres, the whole mass still representing a better cattle food than ordinary hay. The technical problem of making the grass protein into a really attractive and palatable product should not long remain beyond the capacities of our biochemists. When it is pointed out that the total quantity of grass protein grown in Great Britain is something like ten times our normal protein requirements, the potential importance of the direct utilization of even a small fraction of it requires no further emphasis; but the economic and agricultural problems of employing the process on a large scale require further study.

Let us consider now some new technical possibilities in the cultivation of our crops. Much publicity has been given recently to tank-culture or hydroponics. By this is meant the cultivation of plants in culture solutions the concentration and composition of which can be accurately controlled. Such methods are, of course, by no means innovations in the laboratory; it is only their utilization on a large scale for commercially grown greenhouse crops which would be a new departure. It does not, however, seem by any means certain that this technique has any great advantages, at least in the climate of Great Britain, over the method of soil sterilization which was introduced some years ago and is now becoming very widespread.

Another technical innovation from which much can be expected is the use of the recently discovered plant hormones. Knowledge in this field is still growing rapidly but we already understand something of the part played in the growth of a plant by very small quantities of certain essential substances, some of which are in fact identical with the vitamins which we hear so much about in our own diet. Some of the hormones are already quite widely employed to encourage the rooting of cuttings; but there are many more possibilities emerging in the laboratories of the world—for example, the growing of long-fibred stems in textile plants such as flax and hemp, the production of seedless fruits from unpollinated flowers treated with suitable hormones, the control of the opening of flower buds until the danger of severe frost is past, and so on. Moreover, new hormones are still being discovered, some, such as a new pollen extract recently described by the United States Department of Agriculture, controlling growth, while others are concerned with various other phases of a plant's development.

These studies have not yet been brought into relation, although they soon must be, with another very important development which has arisen in practical crop management. Russian biologists in particular have devoted great attention to the investigation of the time of ripening of plants, with the view of developing types which can either survive their rigorous winter or which can crop in a single year after planting in the spring. They have developed a rather elaborate theory of the succession of various phases in a plant's development, which they distinguish sharply from its growth. In general a plant first passes through a temperature phase, in which it requires a certain length of exposure to particular low or high temperatures; this, they claim, is succeeded by a light phase, in which the plant must be subjected to particular conditions of long or short daily periods of illumination. The practical application and indeed the practical basis of this theory is the technique known as vernalization, in which the germinated seeds are artificially given the treatment needed to complete the first phase of development before being sown. Thus a winter variety of wheat, which is normally sown in autumn and lies in the ground over winter, starting to grow in the following spring, may be artificially cooled for the required time and then planted in the spring to crop in the same year. Such methods would be of some value even in England and may be of very great importance in countries with the severe climatic conditions of Soviet Russia, where many million acres have been sown with vernalized seeds. Workers in other countries are not so convinced of the practical value of the method, and the details of both theory and practice are still under discussion. But there seems little doubt that the basic phenomena are quite real and that our understanding of the matter will rapidly become much more profound. It has already been shown that, in certain plants, substances capable of diffusing from a stock into a grafted scion are concerned in controlling whether flowering takes place in the first or second year, that is, with or without subjection to cold and short daylight, and it therefore seems most probable that the whole vernalization question will in time be brought into relation with the discovery of plant hormones already mentioned.

Some Soviet authors have claimed that a single vernalization treatment is sufficient to alter the hereditary constitution of the plants, so that its effects are permanent. Most biologists are likely to doubt the possibility of such a direct action, but it may well be that the Soviet workers have actually discovered a phenomenon of great importance. Since the development of a plant, as we have seen, is profoundly influenced by the early treatment of the seed, a single artificial treatment which causes the plant to mature at an abnormal season may have some effect on future generations owing to the altered conditions under which the seed will be formed. Similarly, another phenomenon on which the Russian scientific workers have laid great stress is the effect of a host plant on the hereditary constitution of a graft; again, the effect may not be a direct one on the hereditary elements as normally understood, but it may be a real phenomenon based on the transmission of something in the nature of a virus.

This brings us to the subject of plant-breeding, one of the fields in which the most spectacular advances are likely in the near future. The breeding of disease-resistant varieties, which, for example, trebled the yield of sugar cane in Louisiana between 1926 and 1929, will probably score some new successes but it cannot be considered a new technical advance. On the other hand, the practical employment of hybrid vigour is a development of the last few years in maize growing. At the present time something like twenty-five million acres are sown with hybrid corn in America, and increases in yield average about 20 per cent. Probably there are similar benefits to be obtained in other crops. The John Innes Horticultural Institution, for example, has prepared hybrid tomato seed with very considerably enhanced productivity.

The most important advances, however, are likely to come from two fields which are still being intensively investigated. The first is the study of the wealth of forms available in Nature for our use. Until recently the range of types employed by the plant breeder has been getting progressively narrower as he concentrated on the improvement of ever more specialized varieties. But it has been realized that much may be gained by the introduction of new hereditary material and it has come as something of a shock to discover how rich is the stock of forms available. Not only are there very numerous local varieties of cultivated plants, each probably with many defects by modern standards although with one or two points of advantage, but there is also a hitherto unexpected variety of wild forms related to the cultivated species. For example, all the cultivated potatoes of the Old World derive from a single species and probably from a very few individuals. We know now at least thirty species, forming a polyploid series, all of which were thought worthy of cultivation by some tribe in South America, and there are also related wild species. They include frost-resistant and short-day forms and varieties resistant to various diseases. It is not too much to hope that we shall fairly soon be able to develop potatoes suitable for the Arctic and for the tropics. The profound results of such a spread of the potato belt do not need to be emphasized.

The second major source of new varieties may be found in the very recent technique of artificially doubling the number of chromosomes in hybrids, thus rendering them fertile and comparatively stable in hereditary constitution. Nearly all our most important crop plants have arisen by a chance occurrence of a similar process in Nature. Now that we have discovered substances, the most important of which is the drug colchicine, which allow us to double chromosome numbers with fair regularity, it is almost inconceivable that we shall not be able to manufacture completely new types of plants of the greatest importance. It is too early as yet to name any examples with complete confidence, but the hybrids of wheat and rye, and of wheat and couch grass may be mentioned as instances of promising beginnings.

An advance of another kind is the recent success in hybridizing yeast. Until recently it was thought that if a single yeast cell was isolated it must give rise to a pure colony. But single yeast cells may be either haploid with one of each kind of chromosome or diploid with two. In the latter case haploid cells will be formed during the growth of the colony and the segregation of different types will occur, so that the final colony is mixed. Winge, in Denmark, has succeeded, by a fine technique of micro-manipulation, in isolating single haploid cells, hybridizing them and finally isolating the segregants from the hybrids. This is the first application of modern breeding methods to some of man's oldest plant collaborators, his assistants in the manufacture of such staples as bread and beer.

If we turn now to the animal field, many of the methods which seem to promise best among plants do not appear very feasible. Thus there are great technical difficulties in making such a full use of hybrid vigour, although some promising results have been obtained with fowls. Again, only the very first steps, in which I have myself shared, have been taken towards doubling the chromosome number in animals, and the difficulties to be surmounted before we can produce fertile hybrids in this way are rather overpowering in prospect.

Perhaps the most important new technique which is just passing from the laboratory into general practice is that of artificial insemination. If the sperm of a selected male is artificially introduced into the female, the greater degree of control over the process makes it possible to employ much smaller quantities than Nature provides, and the number of offspring which can be obtained from a single male may therefore be multiplied some hundreds of times. This makes it possible to ensure that only the very best animals are used as fathers and the constitution of poor stock may thus be quite rapidly improved. The method has already been tested out on quite a wide scale and it has been found possible to send the sperm of desirable males for very considerable distances by air. The method has a very great part to play in the immediate post-war world when we are confronted with the problem of restoring the scorched earth of eastern Europe.

A development of the technique of artificial insemination which seems likely in the next ten or twenty years is the artificial determination of sex by the separation of male- and female-determining sperm. Such a possibility is, of course, a favourite theme of all kinds of charlatanry and psuedo-science. But some recent work, particularly in the U.S.S.R., indicates a serious possibility that the problem will be solved by the method of electrophoresis, that is to say the passage of an electric current through a suspension of sperm, causing an accumulation of the female-determining sperm at the anode and of male-determining at the cathode. There are still many technical details to be worked out, such as the most favourable salt solutions, temperature, etc., but it would be a bold man who denied the possibility of a fairly early solution of the problem. The importance of such a method for the dairy and poultry industries would be profound, but its application to human affairs obviously presents aspects of great difficulty.

It would be in the highest degree desirable to bring about a similar increase in the reproductive capacities of the females of domestic animals. This may be too difficult a task, but some increase can already be envisaged. The administration of suitable hormone preparations, for example, can bring a female into the breeding condition at a time of year when she would normally not be ready to receive the male. Some success has already been achieved in obtaining in this way two crops of lambs a year instead of one. Again, when a female is ready to breed the number of ova produced, and thus the number of young born, is rather restricted in many of our domestic animals, and treatments are being worked out which should make it possible to cause the formation of more ova. This will, in the first instance, enable us to cause a regular production of twins by our beasts. For particular purposes of breeding from exceptionally favourable females it may prove possible, by a technique which has already been used in rabbits, to increase the number of ova many times and to transplant some of them to the uteri of other females, which would then act as foster-mothers from the very earliest stages of the animal's development.

The control over developmental processes given us by the use of hormones may play a part in several other ways. We are beginning to have some understanding of the role of such substances in lactation. We know there are hormones which control the initial development of the mammary glands as well as the intensity of their secretion, and again it has proved possible to influence to a significant degree the content of milk in several important constituents. All these investigations, still essentially laboratory matters, are likely fairly soon to reach the point where we can begin to apply them in practice, when they may open up great possibilities of control over our milk supply, particularly in the difficult winter months.

A somewhat more speculative possibility is the employment of hormones for the control of size. In some animals at least, for example, the rat, it has been possible to obtain considerably increased growth by suitable hormone injections. Further, the embryo of a mammal is in a somewhat similar position as regards its mother as the plant grafts mentioned earlier; an effect exerted primarily on the mother may, by influencing the early development of the fœtus, produce an alteration which will affect the development of the next generation of young and thus be transmitted potentially for ever. That such an influence of the mother on her offspring of the first generation is a possibility is known from crosses between large and small breeds of horse, in which the size of the mother has a great effect on the size of the foal. An effect in more remote generations has been suggested by some workers using extracts of the thymus gland on rats. The matter is still very uncertain, but if it can be put on a firm basis very important results might be obtained. A further and still more speculative possibility may perhaps be worth mentioning; it has been claimed that the very early administration of growth-promoting extracts has a differential effect on those organs which develop most rapidly at early stages, particularly the brain. It is not clear whether the swollen-headed rats so produced were any cleverer than usual, but the possibility of such an effect may be worth considering, if only as a day-dream to solace the despair to which most educators are from time to time reduced. Let us hope, however, that man is already intelligent enough to use, for his benefit and not only for his destruction, the gifts which science offers, without waiting for a hormonally induced enlargement of his brain.

OBITUARIES

Sir Francis Younghusband, K.C.S.I., K.C.I.E.

SIR FRANCIS YOUNGHUSBAND, whose death occurred on July 31, was an outstanding example of that rather rare combination—a philosopher and a man of action. A passionate admirer of the beauties of Nature he had, almost from childhood, pondered and studied the mystery of living things—their origin, their evolution and their spiritual significance—and during his later years he embodied his thoughts and his philosophy in a number of books and papers.

His more practical activities as a man of action found their chief outlet shortly after he arrived in India as a young officer of cavalry. His first journey, in 1886, at the age of twenty-three, was made in company with Mr. H. E. M. James of the Bombay Civil Service, and Mr. H. Fulford of the Chinese Consular Service, when they travelled through large areas of Manchuria and explored in particular the range known as the Long White Mountain. An account of this journey was given by Mr. James in his book of that name, in which he pays tribute to the energy and ability of his young companion, who made himself invaluable in a variety of activities—surveying, the collection of entomological and botanical specimens, sketching, and so on. These wanderings extended over a period of eight–nine months, and were immediately followed by Younghusband's famous journey across Central Asia from Peking to India, culminating in the crossing of the hitherto unknown Mustagh Pass into Baltistan. This journey is described in his own book "The Heart of a Continent", one of the classics of Asiatic (or indeed of any) travel, admirable alike both for the intrinsic interest of the journey itself and for the style in which the book is written. The publication of this book at once placed Younghusband in the foremost ranks of contemporary travellers and writers.

From this on his active life, both as an officer of the Indian Foreign and Political Department and as a traveller, continued almost without a pause until his retirement on pension in 1910. During the years 1888–91 he made a series of journeys through the wild areas of Central Asia, the Pamirs, Kashgaria, and certain hitherto unexplored tracts lying to the north of the Karakoram and Mustagh ranges. These journeys had a political as well as a geographical interest and importance. Later he served in Chitral, and travelled in South Africa as *The Times* correspondent just prior to the outbreak of the Boer War.

Younghusband was thus a well-known figure with a world-wide reputation when, early in 1903, he was appointed by the Viceroy, Lord Curzon, as commissioner in charge of the projected mission to Tibet, then in process of preparation on the Darjeeling frontier.

It was here that I first met him, and in the capacity of secretary and interpreter to the mission I was constantly by his side until he returned to India some sixteen months later on the conclusion of his task, and I was thus able to get to know him intimately and to appreciate his character and his capabilities. A man's character may often, I think, be estimated not so much from his conduct on the great occasions and crises of his life as from his reactions to the petty affairs of everyday and the small worries and mishaps inevitable during travel or a military expedition. Of these we had our full share during the mission—cold, fatigue, boredom, and at times danger and excitement. During all these critical months, when the chief responsibility for success or failure rested on his shoulders, I never once saw him, even for a moment, in the slightest degree flurried, impatient, cross, or in any way perturbed. He remained always cheerful and good-humoured, and apparently indifferent to the small matters which affect ordinary mortals. This was not a pose. It was an attitude of mind based upon his essential equanimity. He knew very well what he wanted and how he proposed to get it, and having thought all this out carefully he was able to relegate all minor considerations to their proper place. But at the same time when any major difficulty or danger, or difference of opinion arose which seemed likely to interfere with his plans or the progress of the mission, he was persistent, inflexible and courageous to a degree.

It was, in fact, greatly due to this combination of qualities—on one hand infinite patience where patience and conciliation appeared advisable, and on the other readiness to fight and to accept risks and responsibilities at critical moments—that our mission succeeded as it did.

It is an old story now and has often been told, but it should be remembered that it was not an easy business. The Tibetans were obstinate and pugnacious; and the dispatch of a mission with a small military escort into the depths of Asia, hundreds of miles beyond the Himalayas, and separated from its base by several lofty mountain passes and (when at Lhasa) by a great unbridged river, resembled more the adventures of Cortes or Pizarro than modern military and diplomatic procedure. There were occasions when failure seemed imminent and inevitable. But, as I have remarked above, it was the combined tact and firmness of the Commissioner which always overcame the crisis, and which eventually secured not merely a favourable treaty with the Tibetans but also the goodwill and friendship which have lasted from that day to this.

I have dwelt at some length on this Tibetan affair, partly because it is the culminating point in Younghusband's career as a man of action, and partly because it presented such an opportunity for the exercise of his peculiar qualities. He retired from the service a few years later, and during the remainder of his life devoted himself to work with the Royal Geographical Society, the organization of the Mount Everest expeditions, and to writing.

During these latter years he published a number of volumes dealing with his favourite subjects: the beauties of Nature, Indian aspirations, and philosophical musings and conclusions. Of these latter the volume which perhaps summarizes most fully the general trend of his mind is "The Living Universe", published in 1933. In this book he traces the genesis and development of this planet from fiery vapour to the present day, and he outlines his conclusions on the vexed and oft-debated question of the origin and evolution of life and intelligence from apparently dead matter. Space does not permit of any attempt to follow him in this thesis, but a perusal of the book will give a good general conception of his attitude towards such questions and the evolution of higher types of beings on this and possibly on other planets; and in some most interesting passages he reveals certain mystical experiences which have come to him.

It was during these latter years, too, that Younghusband organized the World Congress of Faiths, representing all the world's chief religions. The catholicity of his views, and the wide respect which these views commanded, were well illustrated in the memorial service held at St. Martin-in-the-Fields on August 10 when, besides the customary Christian prayers and hymns, extracts from the Hindu, Jewish, Buddhist and Moslem scriptures were read by representatives of each of these faiths.

Such a character is rare, and when his achievements as a soldier, explorer and diplomat are borne in mind, perhaps unique. His friends will always remember him with affection for his patience, tolerance, good humour, simplicity and utter sincerity.

Frederick O'Connor.

Mr. D. B. Mair

David Beveridge Mair, who died at Galashiels on July 21, was well known as a mathematician and was a distinguished member of the Civil Service. He was born in Canada on March 24, 1868. His father, who was a Presbyterian minister, of an Aberdeen family, died young. David Mair was at school at Dollar Academy. At the age of sixteen he entered the University of Edinburgh and obtained first class honours in mathematics and in natural philosophy. He went to Cambridge as a scholar of Christ's, and was second wrangler in 1891. In 1893 he was awarded a

Smith's Prize and in 1894 was elected a fellow of Christ's.

During the next two years, part of Mair's time was spent in study abroad, particularly in Germany, and part in lecturing to honours students at University College, London, under Prof. Karl Pearson. In 1896 he was appointed a junior examiner in the Civil Service Commission; from that time, although he kept up his mathematical studies (including that of relativity), he devoted almost the whole of his energy to his official work. He had a powerful and original mind and would undoubtedly have done valuable work in mathematics in the greater freedom of an academic career. However, he found adequate scope for his abilities in the many problems arising out of the work of the Commission; he became head of the examination branch in 1907 and in 1918 was also appointed an assistant commissioner.

By nature Mair was an ardent reformer; but to the zeal of a missionary he added the remorseless logic of a mathematician and the open-mindedness of a scientific investigator. His prentice hand he tried on the mathematical question papers of school standard, eliminating book work and formal questions such as "solve the equation . . .", and substituting problems, particularly those of a practical nature on matters of everyday life. All candidates were required to use mathematical instruments and in some schemes of examination, for example, Army Entrance, laboratory tests in mathematics were added. For these tests he developed a fully equipped laboratory for the simultaneous examination of a number of candidates. As opportunity arose he endeavoured to get the syllabuses changed by removing the icy hand of Euclid and cutting out dead wood. At a later date somewhat similar treatment was accorded to the examinations of higher standard. There is little doubt that his efforts had a very considerable effect in improving mathematical teaching in Great Britain.

In course of time similar ideas were applied to other subjects, such as natural science, modern languages, etc. Nothing was too small to escape his eagle eye and fertile brain. For example, he devoted much time to drafting a syllabus in handwriting and devising a scheme by which a candidate could obtain full marks for a clear workaday hand, instead of spending laborious hours in order to produce in the examination room a beautiful specimen of what was known as the "Civil Service hand"; for spelling he evolved a type of question paper on a phonetic basis, for which he designed some special symbols.

Naturally, he gave much attention to wider problems such as the drafting of schemes of examination and the adjustment of candidates' marks. As regards the latter subject, the methods used in the Commission were far in advance of those of other examining bodies; little information was published but particulars were readily given to inquirers.

In drafting schemes of examination, Mair endeavoured to bring them into close connexion with the educational system of the country, so that candidates could take the Civil Service examinations in their stride without special preparation at school or college, or recourse to a crammer. Besides the advantage to the candidate, this procedure widened the field and was thus of benefit to the State. He was also strongly in favour of selecting candidates of mature age by interview and record instead of by a written examination—the traditional Civil Service procedure. Further, he was always prepared to experiment with new methods, such as intelligence tests, to devise means of estimating their value, and to discard them if they proved useless.

A great impetus was given to the improvement of the examination methods of the department by the appointment of Mr. (later Sir) Stanley Leathes as first commissioner. He was a man of great ability and wide knowledge, an experienced examiner, and much interested in educational matters, particularly in the teaching of modern languages. In 1919 the Treasury set up a committee to consider the scheme of examination for Class I clerkships, the highest grade in the Civil Service, with Leathes as chairman and Mair as secretary. This Committee produced a very interesting report and recommended many important changes, including the introduction of a *viva voce* test and elementary papers in English, general knowledge, a foreign language and elementary science, in addition to advanced papers in the candidates' special subjects. The scheme, with certain variations, was adopted for the whole administrative group, namely, Class I clerkships, appointments in the Indian Civil Service, Foreign Office clerkships, etc.

During the War of 1914–18, Mair assisted Sir Alfred Ewing in the Intelligence Department of the Admiralty in deciphering intercepted German code messages. In 1921 he went to India to preside at the first examination held in that country for appointments to the Indian Civil Service.

Mair retired from the Civil Service in 1933 on reaching the age limit, and since then spent much time travelling abroad. He was a singularly modest man and never courted publicity. Small of stature but stoutly built, he was of impressive appearance; he had a piercing and very intelligent eye, a clear resonant voice, and a strong chin. He held decided views on most subjects and was always prepared to express them, and, if need be, to throw them overboard. He possessed a dry humour, well under control.

His publications included an elementary text-book on mathematics and one on fourfold geometry. He married in 1897 Jessy, daughter of Mr. William Philip. She survives him with a son and three daughters. Mrs. Mair was for many years secretary of the London School of Economics, and their eldest daughter is Dr. Lucy Mair, well known as an anthropologist.

LENNARD BLAIKIE.

WE regret to announce the following deaths:

Prof. Kurt Brandenburg, professor of special pathology and therapy in the University of Berlin, editor of the *Medizinische Klinik*, aged seventy-three.

Dr. W. A. Bryan, director of the Los Angeles Museum of History, Science and Art, on June 18, aged sixty-six.

Prof. A. Döderlein, formerly professor of gynæcology and obstetrics in the University of Munich, a pioneer in the bacteriology of the puerperium, aged eighty-one.

Dr. Laurence S. Moyer, of the Department of Botany, University of Minnesota, known for his work on the biochemistry and physiology of plants.

Prof. Francis Ramaley, emeritus professor of biology in the University of Colorado, botanical editor of *Ecology*, on June 10, aged seventy-one.

Sir Montagu Sharpe, K.C., the well-known ornithologist, chairman of the Council of the Royal Society for the Protection of Birds, on August 23, aged eighty-five.

NEWS and VIEWS

H.R.H. The Duke of Kent, K.G., P.C., K.T.

It is with deep regret that we record the death of H.R.H. The Duke of Kent on active service in a flying-boat crash in Scotland on August 25. The Duke was thirty-nine years of age. For ten years, as Prince George, he served in the Royal Navy, and it was not until he was withdrawn from active service with the Navy that his talents and capabilities for public service could be thoroughly appreciated. As president of St. George's Hospital, he took a great personal interest in its welfare and prosperity. At the age of twenty-six he joined the Foreign Office and later moved to the Home Office, where he did important work in the inspection of factories and in other problems of sociological interest. His keenness for this work inspired him to sever his official connexion with the Home Office and to study industrial problems at first hand. His prolonged tour of the industrial north in 1931, followed by a series of less formal visits to factories and workshops, will long be remembered.

Sir Harold Scott, K.C.M.G.

Sir Harold Scott, who retires from the post of director of the Bureau of Hygiene and Tropical Diseases on August 31, has made notable additions to our knowledge of tropical medicine and comparative pathology. In Jamaica, when Government bacteriologist, he elucidated the problem of the so-called 'vomiting sickness', proving it to be due to poisoning by the ackee fruit (*Blighia sapida*), a common native food on the island, wholesome when ripe and naturally opened, but highly toxic in its unripe, unopened condition. He also investigated another baffling disease in Jamaica, showing it to be a 'central' and not a 'peripheral' neuritis as previously thought, but of toxic origin closely allied to certain avitaminoses occurring in Africa and elsewhere. As Government bacteriologist in Hong Kong he added much to the knowledge of tuberculosis by his investigation of its prevalence and character among Chinese of the poorer classes. Later, when pathologist to the Zoological Society of London, he was able to compare his three hundred postmortem studies of fatal human cases in Hong Kong with similar studies on wild animals dying of tuberculosis in the Zoological Gardens. His results, published by the Medical Research Council in 1929, throw much light on the pathology of the disease, the portals of entry, and on the lymphatic systems in relation to paths of infection within the body.

As medical secretary of the Colonial Medical Research Committee during 1928–30, and as assistant director and then director of the Bureau of Hygiene and Tropical Diseases, Sir Harold has greatly promoted and encouraged research in the Colonies. His "History of Tropical Medicine", published in 1939 and based on his Fitzpatrick Lectures delivered before the Royal College of Physicians, is a monument of learning and exposition.

Science and the War Effort

Prof. J. D. Bernal, speaking on "Science and the War Effort" at a meeting called by the Staff Associations of the National Physical Laboratory and associated laboratories on July 28, referred to the changing role of science in warfare. The conception of the function of the scientific worker and technician at the beginning of this War, as during the War of 1914–18, was confined to dealing with such technical devices of war as were beyond the scope of Service personnel. It is, however, becoming increasingly realized that science interpenetrates war activities over the whole field, and the scientific method is becoming a general mode of approach to the whole field of military action. During the last 150 years, tradition has ruled warfare and tactical surprise has played a small part. Following the War of 1914–18 an attitude of complacency has ruled and we have not attempted to apply scientific thinking further to war problems. On the other hand, the Germans, having been defeated, have spent the intervening period in making a far-reaching and comprehensive study of the reasons underlying that defeat. It seems to be a general feature of history that a defeated nation intensifies its study of warfare, and produces surprising tactical changes. Thus the enemy has obtained an advantage in that he has built up a powerful war machine based on the scientific method. We have accordingly to set ourselves the task, not only to catch up with him, but also to surpass him quickly.

In setting ourselves to this task we have two advantages. In the first place we have not been subjected to the intensive concentration on war machines to the exclusion of other fields of scientific endeavour; and secondly, whilst German methods are undoubtedly effective, they do not lend themselves to elasticity of thought in new developments. It is here that our free and democratic methods might be turned to good account. Addressing himself to the problem of mobilizing science to speeding up the war effort, Prof. Bernal said we have to apply scientific resources to the War in a strategic way. Thus we must apply all available forces to definite ends. In the past our efforts have been somewhat unbalanced. The probable yield from any effort must become the criterion. Military affairs are such that, owing to the difficulty of changing over, unless, say, a 100 per cent yield is to be expected in a year, the work is not worth doing. There exist generally several restrictive features which must be removed if scientific work is to be fully utilized. Perhaps the greatest handicap is the lack of direct contact between scientific workers and their opposite numbers in the Services. This is often accentuated by excessive secrecy. Some bottle-necks are due to established departmental procedure and others are due to small departments which are trying to deal with a greatly increased volume of work with unexpanded staff and equipment.

The full effects of science on war cannot be felt unless the scientific mind can be brought to bear on the war as a whole. This is not only a matter for the 'higher ups' but every scientific worker has now a widened responsibility, and a revaluation of responsibility is required. This brought Prof. Bernal to his main point, that it is not sufficient merely to work harder than in peace-time. It is also necessary to examine the implications of the work and search for ways and means of expediting progress and improving organization. The person on the job is in a position where he or she can make useful suggestions in these directions, and the speed and efficiency with which we must work require of the person on the job that he does consider this to be a part of his responsibility. Here a special duty falls to the organized scientific workers, and it is now possible, without friction, to carry out the implications of this wider responsibility through joint consultation on matters affecting efficiency. In conclusion, Prof. Bernal expressed the belief that the undifferentiated way of dealing with things which is characteristic of the scientific method, will, given good organization, build up a far better war machine than the one we have against us.

The War and Nesting Birds

The most interesting effect of the War upon nesting birds in Great Britain has been the attraction of the black redstart (*Phœnicurus ochrurus gibraltariensis*) to nest in the air-raid ruins of some English towns. Until the War, this was one of the rarest British nesters, although a regular winter visitor, but on the Continent where it is a familiar town bird it shows a partiality for ruins and it would be interesting if it becomes a commoner British resident in this unexpected way. In 1923 this bird was first noted nesting in Great Britain in a southern county and in 1936 it began nesting in Cambridge. In 1940 and 1941 it nested in the city area of London and a considerable number of London Natural History Society observers watched the birds. Another influence upon nesting birds has been the military disturbance of many coastal and rural haunts, the felling of woods and the draining of marshland. Another rare British nester, the black-necked grebe (*Podiceps nigricollis nigricollis*), was under observation by the Merseyside Naturalists' Association this year at a new nesting site at Abbot's Moss, the third it has used in Cheshire. In Anglesey there was a considerable increase in the number of roseate terns nesting at Llandwyn island, where between sixty and seventy pairs nested this year with Sandwich terns, etc., and new terneries, possibly an overflow of this species, were made at Malldraeth Point and on Ynys Ferrig rocks in Rhosneigr Bay. The kite has, however, maintained its nesting haunt in the valleys of mid-Wales and the black guillemot its recent habitat on the Cumberland cliffs at St. Bees Head.

The British Association

The report of the British Association for 1942 (Vol. 2, No. 6) is now available (price 5*s*.), and contains the full text of the papers given at the conference on European agriculture held by the Division for the Social and International Relations of Science in London during March 20-21, 1942. Problems in post-war reconstruction was the subject of discussion at the conference, the papers falling into four main sections: measures for reconstruction, economic and kindred problems, the future betterment of European farming and problems of peasant farming. The contributors, many of whom came from occupied countries and represented very different types of farming, were remarkably in agreement as to the causes of pre-war agricultural problems and the main lines upon which future reconstruction should be based, namely, the development of small-scale peasant farming, concentrating primarily on live-stock, fruit and vegetable production in order to raise the standard of living and nutrition.

In addition, the report contains an article by Sir Henry Lyons on the work of the International Research Council (now the International Council of Scientific Unions) which will be of special interest to those concerned with the possibility of increasing collaboration in science through some form of standing organization, and an account of the peace-time activities of the British Association by its president, Sir Richard Gregory.

The Study of Soils

The Cantor lectures delivered at the Royal Society of Arts by Dr. B. A. Keen in January and February on soil physics, soil cultivation, and cultivation and crop yields have been published in the Society's *Journal* (**40**, 545; 1942). The study of soil physics is relatively new, and only within the last twenty or thirty years has this side of agricultural practice been placed on a sound theoretical basis. The substitution of the pore-space theory in place of the capillary-tube hypothesis as an explanation of the water relations within the soil has, for example, led indirectly to improvements in certain practices in irrigation areas and in land drainage. The effectiveness of different types of cultivation and the influence of weather on the formation of tilth can now be measured by studying the resulting soil structure, and both the design, performance and use of implements can accordingly be put on a more scientific basis. As regards the effect of cultivation on crop yield, the traditional views held in Great Britain are called in question. Experiments on certain soils have shown no special benefits to the crop from additional or increased depth of cultivation, and since cheap labour is no longer available and every mechanized operation costs fuel and oil, a plea is made for similar investigations to be carried out in widely different districts, so that reliable information of a more general nature on such an important economic question may be forthcoming.

Canadian Water Supplies

Eight years ago the Canadian Department of Mines and Reservoirs began a survey of all the water supplies in Canada, with the view of determining the mineral and other content of the industrial and domestic water of the Dominion. The final results of this survey are now published in "Industrial Waters of Canada", by H. A. Leverin (Ottawa: King's Printer. Pp. 112. 25 cents). The investigation involved the determination of suspended matter, silica, iron, calcium, magnesium, sulphate, alkalis, potassium, bicarbonate, free carbonic acid, chloride, nitrate, oxygen, hydrogen-ion and colour. The report discusses the origin and distribution of these impurities and their importance in many industrial processes. It appears that distilled water is necessary not only in the manufacture of chemicals or drugs but also in the manufacture of ice, storage batteries, yeast, aerated waters and the plating of mirrors. In the paper and pulp industry, in the making of such varied commodities as textiles, soap and ice, and in brewing, distilling, baking, tanning, canning, etc., the nature and amount of the impurities are of much significance. The processes used in the investigations are fully described, and the publication contains tabulated analyses of surface and civic water supplies and maps showing the hardness of town water supplies throughout the Dominion.

Tuberculosis in El Salvador

The March issue of the *Boletin de la Oficina Sanitaria Panamericana* contains an interesting paper by Dr. Rafael Vega Gomez, head of the Tuberculosis Department and ex-director of health, El Salvador, on the control of tuberculosis in his country. The campaign against the disease began in 1928 with the foundation of a National Tuberculosis Sanitorium, in which the number of beds has risen from 30 to 105. Previously the only accommodation for tuberculosis were some rooms in the Hospital Rosales of El Salvador. In 1931 the local Red Cross opened the first public dispensary and founded the National Anti-tuberculosis League. Five years later another dispensary was opened at Santa Ana. In 1939 the director of health created a Department of Tuberculosis and in 1940 opened a new dispensary where 14,000 examinations were made and 93 per cent of the contacts were investigated, while 5,000 homes were visited. In 1938 the first census was taken to determine the amount of infections among school children in the capital; 4,151 were examined. The Montoux and Pirquet tests were found to be positive in 32·8 per cent of the five to six year olds, and in 62 per cent of those aged 14–15. Similar results were obtained in Santa Ana in 1939. Of 12,000 apparently healthy persons at El Salvador in a population of 100,000, 1·42 per cent showed signs of active tuberculosis. Recent figures showed a distribution of 22 per cent, 64 per cent and 14 per cent among the minimal, moderate and advanced lesions respectively, which are very encouraging figures compared with those of 1932, when about 72 per cent of the cases showed advanced lesions.

Suppressing High-Frequency Disturbances from Telephone Apparatus

In an article by M. E. Krom (*Bell Lab. Rec.*, 20, No. 10, June 1942) it is pointed out that disturbances such as those arising from the opening of the contacts of a telephone dial may be represented by an infinite number of alternating currents extending upwards through the entire radio spectrum. Disturbances of this type may reach receivers by direct radiation, by coupling between the telephone line and receiving antenna, or by secondary coupling via some outside electrical system such as a power line. Two general types of suppression devices are available to limit noise influence. One, located at the source, tends to reduce the radio-frequency voltages developed; the other—usually remote from the source—is functionally a low pass filter. The former type most commonly consists of a small inductance and capacitance connected across the dial contacts. The inductance prevents too rapid a build-up of current as the contacts close whilst the capacitance reduces the voltage on the telephone line as they open.

The filter action results in the voltage increasing slowly as the contacts open, instead of producing a series of high-frequency surges, and 40–55 db. suppression is obtained. Another type of filter similar in action but of different characteristics, is used to suppress radio-frequency voltages from teleprinters and affords some 50–60 db. suppression over the range of from 200–30,000 kc. The disturbances from power plant associated with telephone equipment are usually effectively suppressed (20–25 db.) by simple condensers. Where the individual sources of noise are numerous the second general type of device—the low pass filter—is used, and it may consist of an inductance connected in series with each side of the line, the outgoing ends of which are terminated by a condenser connected to earth. It is desirable that inductive elements used in radio filters have a high effective resistance over a wide band of frequencies instead of a peaked impedance at the resonant frequency.

Man-Made Radio Interference

An article by R. A. Shetzline (*Bell Lab. Rec.*, 20, No. 10, June 1942) reviews the factors involved in this increasingly important subject. Opening with a brief reference to the multi-frequency disturbances caused by the operation of a relay or switch, the author cites an example of a telephone line and an adjacent power line as a source of interference to a nearby radio receiver. Attention is directed to the signal-to-noise ratio of a receiver as the criterion of its performance, and it is shown how this ratio is dependent on the field intensity of the received radio signal and on the effectiveness of the antenna, the latter being a function of the effective height of the antenna and the impedance relations between antenna and receiver.

Expressions are evolved from which it becomes apparent that the best radio reception is obtained when the field intensity, antenna efficiency, line coupling loss and the attenuation along the line are greatest; the latter depends upon whether the line be cable or open wire. Interference by direct radiation becomes of importance only when the source is close to the antenna or on the same premises as the receiver. Experience has shown that in many instances noisy reception reports arise only when distant stations are sought. With field strengths of reasonable values, and with suitable antenna circuits, simple preventive measures should mitigate the annoyance caused to radio listeners by telephone apparatus.

The Night Sky in September

The moon is new on September 10d. 15h. 53m. U.T. and full on September 24d. 14h. 34m. The following conjunctions will occur during the month: Sept. 2d. 20h., Saturn in conjunction with the moon, Saturn 3° N.; Sept. 6d. 00h., Jupiter in conjunction with the moon, Jupiter 4° N.; Sept. 9d. 05h., Venus in conjunction with the moon, Venus 2° N.; Sept. 9d. 15h., Venus in conjunction with Regulus, Venus 0·7° N.; Sept. 12d. 15h., Mercury in conjunction with the moon, Mercury 6° S.; Sept. 30d. 05h., Saturn in conjunction with the moon, Saturn 3° N. Mercury, in greatest elongation, 27°, on Sept. 15, is an evening star and unfavourably placed for observation for northern observers. Venus is a morning star, and Jupiter in Gemini is well placed for observation in the morning. Saturn and Uranus are not very far from Aldebaran and appear in the east before midnight. No occultations of any bright stars will occur during the month. The longer evenings provide an opportunity for seeing many interesting sights such as the Pleiades, the variable star Algol, the Great Nebula of Andromeda close to the star ν Andromedæ, and other objects of interest.

There will be a partial eclipse of the sun on Sept. 10, visible at Greenwich. The circumstances of the eclipse at Greenwich are as follows:

Magnitude	Eclipse begins	Greatest phase	Eclipse ends
0·33	15h. 24m.	16h. 17m.	17h. 07m.

Announcements

Sir Henry Dale, who was recently appointed a member of the Governing Body of the Lister Institute of Preventive Medicine, has been elected by the Board as its chairman.

An open meeting of the Association of Scientific Workers will be held on September 4 at 7 p.m. at the Caxton Hall, London, S.W.1, to discuss and support proposals for a Central Scientific and Technical Board. The speakers will include Lord Strabolgi.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Non-effect of Massive Doses of Progesterone and Desoxycorticosterone on Lactation

UNTIL recently, progesterone has been generally regarded as devoid of mammary growth stimulating activity in most species. Its positive action in the mouse appeared to be exceptional[1], though doses of 4 mgm. daily were without effect in the rat[2]. It has lately transpired, however, that massive doses (15 mgm. daily) promote mammary development in the rat[3,4]. Two progesterone derivatives, desoxycorticosterone (21 - hydroxy - progesterone)[5,6], and pregneninolone (anhydro-hydroxy-progesterone)[7] have also recently been shown to exhibit mammogenic activity.

Date	Mothers			Litters			
	Treatment	No. in group	Mean wt. on 6th day of lactation (gm.)	Total No. of pups on 1st day of lactation*	No. of pups weaned	% weaned	Mean wt. at weaning (gm.)
Jan. 1942	Sesame oil (control)	4	303	32	31	97	42·9
,, ,,	10 mgm. progesterone daily ..	4	234	31	29	94	38·4
,, ,,	5 mgm. DOCA daily	4	263	31	30	97	42·3
May 1942	Sesame oil (control)	4	230	32	29	91	40·7
,, ,,	15 mgm. progesterone daily ..	3	250	24	22	92	40·7
,, ,,	10 mgm. DOCA daily	3	237	24	22	92	37·6
,, ,,	4 mgm. pregneninolone daily ..	3	240	22	22	100	35·4

* Litters were reduced to eight at birth.

In 1937, Folley and Kon[8], on the basis of existing evidence, put forward the generalization that substances showing mammogenic activity also possess the power to inhibit established lactation. The question therefore arises whether or not this generalization is in accord with the new facts mentioned above. The effect on lactation in rats of the three steroids in question was accordingly investigated.

The experimental technique and method of studying lactation were as described previously[8,9], facilities for working with rats being kindly provided by Dr. S. K. Kon. Progesterone and desoxycorticosterone acetate (DOCA) were given by subcutaneous injection in sesame oil (1 ml. daily). The administration of large doses of pregneninolone presented some difficulty on account of its relative insolubility. For this reason the maximum daily dose that could be conveniently given was 4 mgm. dissolved in 2 ml. of propylene glycol. In the first series of experiments (January 1942), ten consecutive daily doses were given and in the second series, eleven, in all cases beginning on the sixth day of lactation. The results are summarized in the accompanying table.

It is evident that in the experiments with progesterone and desoxycorticosterone acetate no detectable inhibition of lactation occurred. Folley and Kon[8] had already shown that administration of 1 mgm. progesterone daily to rats had no inhibitory effect on lactation; it is interesting now to find that in rats from the same colony doses fifteen times as great are equally without effect. It may be noted that the dosage per unit of body weight in these experiments is smaller than that which Selye[3] used to obtain mammary growth, since his rats weighed only 108–141 gm., but mammary growth was reported by Reece and Bivins[4] using the same dosage in rats weighing 217 gm.

The negative results with 5 mgm. and 10 mgm. of desoxycorticosterone acetate daily are rather surprising, since Gaunt[10] in experiments on adrenalectomized rats obtained slight evidence that desoxycorticosterone inhibits lactation. However, in intact rats receiving 0·5 mgm. daily, he observed no inhibition.

Only with pregneninolone was there any evidence of interference with lactation. In this group the growth curve of the pups underwent a slight depression beginning immediately after the injections were instituted.

It might appear from these results that the generalization proposed by Folley and Kon is no longer tenable. It is possible, however, that the threshold for the mammary growth response may be lower than for inhibition of lactation and that administration of even higher doses of these steroids might give positive results. These results are published now since they are of some interest and because further experiments with higher doses of progesterone are unlikely to be possible in the near future.

I am indebted to Messrs. Organon Laboratories Ltd. for progesterone and desoxycorticosterone acetate, to Messrs. Ciba, Ltd., for desoxycorticosterone acetate and anhydro-hydroxy-progesterone and to Messrs. Schering, Ltd., for progesterone provided before the War.

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National Institute for Research in Dairying,
Shinfield, near Reading.
Aug. 12.

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Collection of Eggs from the Fallopian Tube of the Rat

DURING the course of recent experiments in collaboration with Mr. P. C. Williams, an account of which will be published later, it has been noted that ovulation and superovulation can be produced in both intact and hypophysectomized immature rats by a single injection of mare serum gonadotrophin followed by a single injection of chorionic (urinary) gonadotrophin. In hypophysectomized rats, ovulation takes place 13–14 hours after the administration of the luteinizing hormone (chorionic gonadotrophin). The number of eggs produced may be very large; in one rat no less than forty-nine eggs were present in the Fallopian tubes.

In keeping with the observations of Long[1], I have examined the Fallopian tubes of such rats in the fresh condition in order to avoid the cutting of a large number of serial sections, and to facilitate the rapid collection of the eggs. The method adopted is as follows: The Fallopian tube is uncoiled by microdissection. When superovulation has occurred, macroscopic observation reveals a characteristic swelling or bulging of a short length of the tube near its ovarian end. This swelling, visible to the naked eye, has a glassy appearance which is in sharp contrast to the opacity of the remainder of the tube. Under a binocular dissecting microscope the swollen part of the tube is seen to contain the eggs (Fig. 1). Each egg is surrounded by a dense mass of cumulus cells, and the cell-masses are held together by a translucent gelatinous fluid (Fig. 2). Ovulation of the normal number of eggs does not produce a cell-mass big enough to cause this swelling, though the binocular microscope enables the eggs to be seen quite easily in the tube, as described by Long. The eggs are collected by excising the egg-containing segment of the tube, and applying gentle pressure at one end of the segment to squeeze out the contents.

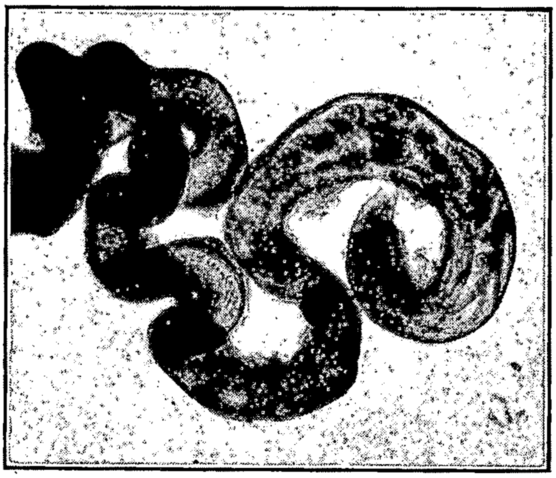

Fig. 1.

FALLOPIAN TUBE OF HYPOPHYSECTOMIZED RAT AFTER SUPEROVULATION, SHOWING THE SWOLLEN EGG-CONTAINING SEGMENT. (×15)

Long removed the surrounding cumulus cell-mass and corona radiata by immersing the eggs in a sperm suspension, but the recovery of the eggs is then made difficult by the opacity of the fluid. I have made use of the observations of Yamane[2] and Pincus and Enzmann[3] that the dispersal of the follicular epithelial cells surrounding the egg can be effected by the supernatant fluid from a centrifuged suspension of spermatozoa previously killed by heat, or by a solution containing trypsin. The former of these methods has been applied with success. A sperm-free solution, prepared in this way, causes disintegration of the cumulus and corona radiata surrounding the egg of the rat in about one hour. The eggs, now surrounded only by the zona pellucida, can then be removed with comparative ease from the medium.

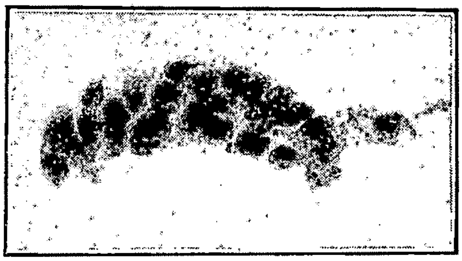

Fig. 2.

CONTENTS OF THE SWOLLEN SEGMENT, ABOUT 20 EGGS SURROUNDED BY CUMULUS CELL-MASSES CAN BE COUNTED. (× 15)

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August 7.

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Vitamin C in Walnuts

THE fact that unripe walnuts (*Juglans regia*) contain very large amounts of vitamin C appears to have been first reported by Gergelezhiu[1] in 1937. This remarkable observation that a fruit as large as the walnut contains 1,000–3,000 mgm. of vitamin C per 100 gm. appears to have been overlooked in English-speaking countries although the findings have since been confirmed by German workers[2]. It has been shown by the Russian author that the vitamin C content is at its highest at the stage of development when the kernel is soft and just before the formation of the shell.

TABLE 1

VITAMIN C IN DIFFERENT SPECIES OF WALNUTS

	mgm. per 100 gm.
Juglans regia—source A	1460–1800
—source B	1520–1640
Juglans regia v. *sinensis*	1120
Juglans cathayensis	860
Juglans nigra	700
Juglans cordiformis	680
Juglans rupestris	510
Juglans mandshurica	410

We have recently examined a number of species of walnuts. It can be seen from Table 1 that of these the cultivated edible walnut contained the highest concentration of vitamin C. The figures for the less common Juglans species must be taken as approximate since it was not possible to ensure that the specimens were analysed at the stage of development when the vitamin content was highest.

The analyses shown in Table 1 were carried out on the whole fruit by the usual titration with 2.6 dichlorophenol indophenol. In order to verify the specificity of the method for green walnuts the following tests were done. Although Harris and Olliver[3] have shown that tannins are unlikely to interfere with the vitamin C determination, Gatti and Knallinsky[4] have reported that such substances reduce the dye. Precipitation of walnut extracts with gelatin and acid salt solution, which completely removed the reducing activity from tea extracts, caused no reduction in the apparent vitamin C concentration of the walnuts for 30 minutes. Furthermore, treatment of walnut solutions with ascorbic oxidase prepared from cucumber[5] caused a loss of 98·4 per cent of their activity. The high indophenol-reducing properties of walnuts appear, therefore, to be due to vitamin C.

In order to discover whether this surprising concentration of vitamin C was a characteristic of the walnut or was shared by other nuts a number of different types were examined. All these nuts were in an unripe condition similar to the walnuts.

TABLE 2

VITAMIN C IN UNRIPE NUTS

		mgm. per 100 gm.
Juglans regia	walnut	1460–1800
Pterocarya Rehderiana	Rehder's wingnut ..	1540
Carya ovata v. *pubescens*	a hicory	820
Carya ovalis v. *obcordata*	,, ...	580
Carya glabra	,, ...	460
Pterocarya sternoptera	a wingnut	440
Carya alba	a hicory	70
Æsculus Pavia	a horsechestnut ..	20
Prunus Amygdalus	almond	20
Æsculus Hippocastanum	common horsechestnut	8
Æsculus carnea	red horsechestnut ..	5

In spite of the active enzyme systems in walnuts which cause rapid blackening when cut surfaces are exposed to the air, Gergelezhiu found that the vitamin C is remarkably stable. The methods commonly used in the U.S.S.R. for preparing sweet confections from walnuts, however, destroy all the vitamin C. The pricking and brining, followed by exposure to sunlight or treatment with steam used in making the pickled walnuts popular in Great Britain also completely destroy all the vitamin content. If, however, walnuts are pickled by either of two methods published by Mrs. Hannah Glasse in the eighteenth century the whole of the vitamin C is retained. Walnuts can also be used as a source of vitamin C in the diet in the form of jam or chutney.

TABLE 3

UNRIPE WALNUTS AS A SOURCE OF VITAMIN C IN THE DIET

	Vitamin C mgm. per 100 gm.
1. *Green pickled walnuts.* Unripe nuts peeled very thinly; soaked for 24 hours in 15 per cent salt solution; packed in spiced vinegar (without cloves); left for 3 months	1080
2. *White pickled walnuts.* Unripe nuts peeled until white; soaked for 12 hours in 15 per cent salt solution; transferred to a second salt solution and simmered for 5 minutes; packed in spiced vinegar (without cloves); left for 3 months ..	1070
3. *Walnut marmalade.* 230 gm. unripe nuts sliced into 560 ml. boiling water; boiled until soft (40 min.); 340 gm. sugar added, boiled until set (20 min.)	630
4. *Walnut and blackcurrant jam.* Jam made with 453 gm. nuts, 112 gm. blackcurrants and 560 gm. sugar	520
5. *Walnut and green tomato chutney.* 680 gm. nuts, 453 gm. green tomato, 225 gm. shallots, 225 gm. raisins, 225 gm. sugar, 5 gm. mustard seed, 15 gm. salt, 880 ml. vinegar, 25 ml. saccharine solution ..	410

The samples of pickles, of which the analyses are given above, were made in 1940. The determination of vitamin C was carried out in August 1942. When it is considered that orange juice contains about 45, rose-hip syrup 200 and blackcurrants 300 mgm. vitamin C per 100 gm., the concentration in walnuts pickled as indicated above is very remarkable. A single walnut weighing 15 gm. will provide 150 mgm. of vitamin C, or at least twice the maximum daily requirement.

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RONALD MELVILLE.
HENRY SARSON.

Aug. 5.

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Mating Swarm in a Chironomid, *Spaniotoma minima*

A DIFFICULTY often encountered in the study of the habits of mosquitoes is the failure of many species to mate in confined spaces in the laboratory. To overcome this difficulty larger and larger chambers have usually been constructed to gain space for the formation of a mating swarm (Hackett[1]). Lloyd[2] notes this difficulty with the chironomid, *Spaniotoma minima*, one of the common sewage flies. In the course of recent investigations I have succeeded in overcoming the inhibition in this species without enlargement of the insectary, and the conditions found to limit the mating of this insect may have possible applications to malariological problems.

The insects, which are positively phototropic, were found to mate very freely in small glass bell-jars, if the light was not decidedly from one side. Screening the window light and placing an electric lamp directly over the bell jar resulted in a typical dance, accompanied by free mating. In a glass box, 20 in. × 10 in. × 12 in., swarming was most active when the source of light was directly above, but swarming and mating also occurred with illumination from below and also, though less freely, when the four sides of the box were equally illuminated. All round, rather than unilateral, illumination would seem to be essential, therefore.

Below 10 foot-candles, swarming in laboratory cages declines with decreasing light intensity. In the field the flies are found swarming in early morning so soon as it is possible to perceive them and before the photometer will register (that is, below 0·25 f.-c.). The swarms increase with increasing light and in calm weather the flies may be seen dancing in great abundance in bright sunlight, so that swarming occurs over a wide range of light intensity. The lower temperature limit for swarming is 46° F. and for mating 48° F. There appears to be no upper limit for either process under natural conditions. Swarming has been seen to take place on hot, dry days in summer and also during fog and rain. Relative humidity therefore seems to have no influence on its occurrence. When temperature is favourable, wind is the most important factor governing the occurrence of swarms in the field. At velocities below 50 ft. a minute swarming is at a maximum and is progressively reduced up to 200 ft.

a min. (2·27 m.p.h.), which is about the inhibiting force. When wind is of interfering velocity, shelter is chosen wherever possible, but, other things being equal, areas of brightest illumination are preferred. Swarms are therefore found (1) over patches of lighter ground colour and reflecting areas (for example, sheets of water), and (2) behind barriers which give shelter or over raised objects which set up eddy currents counteracting the main wind force.

The sexes are equally abundant, but, as is usual with swarming chironomids, males predominate to some 93 per cent in the established swarm. When, however, a swarm is freshly induced in the laboratory, the proportion of females is at first high, but since the males return to the swarm after mating, whereas the females do not, the customary sex proportion (93 per cent males) is soon attained. Single females or single males will dance freely with the same characteristic motions.

Swarming does not appear to condition the reproductive organs of the males for copulation, and no change is found in the distribution of sperm after dancing. The purpose of the swarm appears to be to bring the sexes of a species together, since the various species of swarming Diptera form dances characteristic in height and pattern, and probably also to stimulate the insects to the necessary pitch of excitement for successful copulation.

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Department of Zoology,
University,
Leeds. Aug. 1.

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Cambridge Scientific Workers and the War

IN an article under the above heading[1], the following passage occurs in reference to research topics suggested or approved by the Advisory Research Council of the Chemical Society: "It was stated that the majority of these problems are long-term problems related to the improvement of the post-war prospects of the chemical industry. . . ."

No such statement has been made, by me as chairman of the A.R.C.C.S., or in any authorized pronouncement of this body. The topics adopted cover a very wide range and many are directly related to the war effort or to conditions arising from the War; a considerable number have a chemotherapeutic or medical interest. In a number of cases the investigator has been put into direct touch with a Government department and an extra-mural research of that department has been started as a result. On the other hand, it is true that we have accepted suggestions made by the chemical industry, and we have done this in the belief that stagnation must result unless development is continuous.

The organic chemical industry, like the human body, has certain permanent elements, but it also includes much that needs rejuvenation and constant improvement. It must be emphasized that all the work of this kind, sponsored by the Council, has been suggested by industry itself; we have initiated none of it.

It is true that studies of industrial interest have been made, with great success, at Cambridge, and an explanation on the above lines has probably been given. But it is an argument from the particular to the general to conclude that all, or most of, the work recommended by the A.R.C.C.S. is of this character.

Just as Mr. Churchill declared that the popular demand for a second front was a healthy sign, so we must all sympathize with the agitation for the better use of scientific workers in the War without necessarily agreeing that all the panaceas put forward are feasible. The subject bristles with difficulties and it is often forgotten that a considerable scientific man-power is already available to the Ministries in their research establishments and existing extra-mural contacts with university and industrial laboratories. Obviously it is only a residuum of worth-while *ad hoc* problems that cannot be tackled. During a war we have to find men for jobs, not jobs for men.

It is equally clear that the directors of official research and their assistants and consultants have no monopoly of originality, initiative, foresight, or knowledge; no one of them would claim that he must have thought of everything. Therefore, the pressing need is not for the farming out of specific tasks but rather for the elaboration of a mechanism of contact so that fresh minds and new ideas may be brought to bear on our problems.

Failing such opportunities for present service, need anyone be ashamed of pursuing what is strangely called 'academic' research? Students must be trained in technical subjects and consequently must have teachers. If the latter can find war work to do in addition, it is all to the good; if not, they are still useful and necessary members of the community and it is their duty to keep themselves intellectually alive by making contributions to knowledge. Experience shows that the enthusiasm of undergraduates is fully evoked only by direct contact with teachers inspired by the spirit of active investigation.

A speaker at the conference, of which the article referred to is a summary, defined 'war research' as work which will *very probably* give results applicable to *this* war. Earlier it is stated that junior members of university laboratories should be provided with more of the right sort of problems to solve. The combination of these views implies a serious criticism of the scientific activities of the Ministries which would be hard to justify. Is it suggested that there exists a mass of clearly useful short-term projects which has been neglected? If it is so, the remedy should be the strengthening of the official technical establishments (possibly extra-murally) because, once a short-term desideratum has been recognized, it must be attacked energetically and cannot be left to unconnected volunteers. Therefore we must envisage an expansion of extra-mural contracts with the universities, and teachers outside these arrangements should make independent efforts to get inside them. Failing this, real research by teachers is real national service.

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Oxford.
August 9.

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[1] NATURE, 150, 186 (1942).

WE are glad to publish Sir Robert Robinson's communication since, as he points out, individual men of science and, indeed, scientific bodies, in their enthusiasm, seem to forget that much is already being done both within and outside the various Ministries. We feel, however, that during a war we should find not only men for jobs but also jobs for men. The Central Register is now extending its activities to cover the latter.—EDITORS.

NATIVE PROTEINS, FLEXIBLE FRAMEWORKS AND CYTOPLASMIC ORGANIZATION

By Dr. DOROTHY WRINCH
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A REVIEW of recent work in physical, physiological and enzyme chemistry, and crystallography[1] yields a rather definite and precise picture of the native protein. In consequence of the widespread phenomenon of the reversible dissociation of native proteins into aliquot parts[2], it is necessary to assume that the native proteins, consisting in some cases of molecules in monomeric form—which we shall call protein units to indicate that they cannot dissociate further without losing their protein character—are in many cases particles, consisting of aggregates of protein units[3]. The protein unit, it appears, is a rigid atomic framework formed by the interbonding of the skeletal atoms of the residues. In consequence the C_α atoms carrying the amino acid *R*-groups and the C_α—N atoms holding the imino acid rings form fixed patterns in space. It is, we suggest, the spatial patterns of the N—C_α—C atoms in the skeletons which define the protein character and the allocations of this and that variety of residues to the various positions in these skeletons which define the specific characters of individual units. Such a picture, suggested by data from so many fields, seems definitely required by immuno-chemical findings[4], which make it necessary to postulate that the specific *R*-groups on protein antibodies are held in spatial patterns on the molecular surfaces[5]. To complete the description of protein particles and protein frameworks in general, it is necessary, in addition, to specify the way in which the individual protein units—which need not be identical—are associated. It is the nature of these associations and the implications regarding the nature of systems of native protein units in general which are the subject of this communication.

It seems probable, as has often been suggested by protein chemists, that the units are in some cases held together by means of covalent bonds, for example, when a cystine residue is knitted into the skeleton of two units or when peptide bonds are formed between basic and acidic *R*-groups of different units. Evidence as to the mild treatments which disrupt some protein particles indicate, however, that in many cases the association is not of this type, and a study of structure analyses of crystals of molecules containing groupings of the types present in the *R*-groups of proteins provides a number of precise suggestions as to possible ways in which associations can occur. We find two different kinds: by means of polar links and by the apposition of comparatively non-polar groups[6].

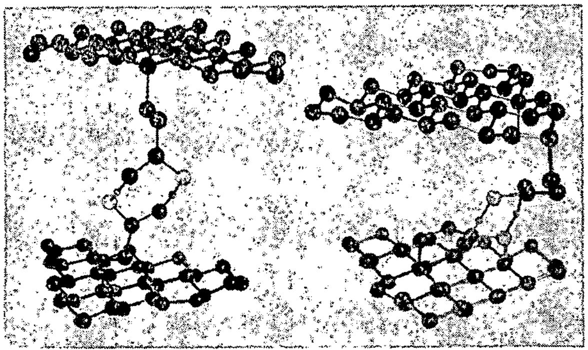

Fig. 1.

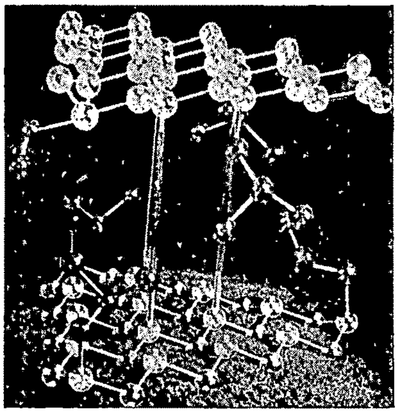

Fig. 2.

The first set includes the following, each based upon a precedent established by structure analyses. (I) Association by hydrogen bridges of glutamic or aspartic acid *R*-groups through their carboxyl groups, with or without the intermediary of 'foreign' molecules (for example, waters). (Precedents: formic acid, oxalic acid and oxalic acid dihydrate.) (II) Association by hydrogen bridges of residues the *R*-groups of which contain COO^- and NH_3^+ groups. (Precedents: glycine, alanine.) (III) Association of *R*-groups containing hydroxyls, with or without metallic ions as intermediates. (Precedents: sugars and metallic hydroxides.) On the basis of the distribution of oxygen atoms around metallic ions in the latter cases, similar associations of COO^- groups on glutamic or aspartic acid residues may also be suggested. (IV) Association by hydrogen bridges of acid amide residues through their CO—NH_2 groups, as shown in Fig. 1, in which the apposed portions of skeletons are indicated diagrammatically by laminæ of atoms. (Precedent: acetamide.)

Suggestions regarding the second type of association, depending upon van der Waals attractions between less polar groups, can be obtained from a study of hydrocarbon crystals. As an example, Fig. 2 shows a possible (trigonal) arrangement of leucine residues on apposed faces, terminal methyl groups from each surface fitting into pockets formed by terminal methyl groups on the other.

The considerable surface areas on native proteins can thus be held together, provided enough groupings are associated. An array of trigonally arranged glutamine residues, for example, on each of two apposed surfaces, could interlink somewhat as in the acetamide crystal. This and the leucine case provide examples of the way in which *R*-groups, *when rooted in an atomic fabric*, can form surfaces of high specificity and how such patterned surfaces can complement one another, as occur in immunological phenomena[5].

The association of homologous chromosomes may prove capable of interpretation in terms of such patterns, in the special case in which they are not only complementary but also self-complementary. Such interrelations between surfaces, permitting the simultaneous associations of groups each no stronger than those holding together molecules of normal size, but all together adding up to a considerable sum, would seem to be one of the essential factors in the crystallization of megamolecules, as well as in the formation of megamolecular particles[7], including antigen-antibody complexes[5].

Both types of association may also be expected to take place intramolecularly, thereby stabilizing the native protein structure. That such associations (for example, of acid amide groupings) may be a major factor in stability is indicated by recent studies[8]. When they take place intermolecularly, the various orientations and degree of extendedness of the *R*-groups (see Fig. 1) give a certain flexibility to the particle. Just as a molecule consists of atomic units held together by covalent bonds, so a protein particle consists of protein units held together by the association of skeletal atoms and/or *R*-groups, but whereas the strongly bonded atoms hold each other at definite distances in definite directions, the native protein units associated through their polar or non-polar groupings do not. Such associations allow them to lie at various distances apart up to a fixed maximum and in a variety of orientations. I suggest that this aspect of the possible types of associations of native protein units gives the key to the 'plasmolytic' capacity of many native proteins to form crystals containing very different water complements[9]. They also suggest an explanation of the nature of cytoplasmic organization and of the many 'anomalous' properties of protoplasm.

It should also be pointed out that this idea of cytoplasmic organization as depending upon flexible frameworks of native protein molecules leads at once to a simple hypothesis as to the nature of biologically active membranes. On this picture they are to be regarded as *molecular fabrics*, that is, as two-dimensional arrays of native protein units, interlinked by *R*-groups, possibly with some ions[10] and other foreign molecules (water, sugars, lipids, etc.) as intermediates: possibly as two or more of such fabrics superposed. Points at which the native protein units are interlinked by groupings of non-polar character will then be permeable, highly selectively, to non-polar molecules. The open structures in the neighbourhood of interlinking *R*-groups of polar type, the stereochemical requirements of which prevent a closely packed arrangement, will permit the passage of water molecules and of polar molecules of suitable size, shape and nature. In particular, the type of association suggested in (III), following the study of the possible intermolecular links in the insulin crystal, would seem to throw light on some of the striking facts regarding the effect of, for example, copper in very low concentrations on biological membranes[10].

Detailed suggestions as to the nature of these various types of flexible frameworks which appear to form an essential feature of living systems, including the biologically active membranes and immune bodies, will be published shortly.

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THE BRITISH RHEOLOGISTS' CLUB

THE seventh general meeting of the Club was held at the laboratories of the Electrical Research Association, Perivale, Middlesex, on July 25, Dr. Stanley Whitehead being in the chair.

A discussion on the "Design and Standardisation of Rheological Apparatus" was introduced by Mr. J. G. Gage. Mr. Gage quoted Bingham's remark that the apparatus used in the young science of rheology corresponded to that used by Faraday in the early days of electrical science. He went on to outline the four main types of flow-curve with which rheologists are familiar, corresponding to Newtonian, pseudo-viscous, plastic (Bingham) and hysteresis systems, in the last of which the flow-curve depends on stress history. He briefly described the principal types of instrument used to study these systems: capillary viscometers, which he regarded as unsatisfactory for thixotropic systems; Couette and Stormer rotation instruments; the multiple jet Gardner mobilometer and its modifications; falling sphere viscometers, etc.

Mr. de Waele disagreed with Mr. Gage's views on the relative merits of capillary and rotation viscometers, claiming that we know more of the hydrodynamics of the capillary tube than of the rotation instrument. He regretted that the work of Rabinowitsch had not been more widely appreciated. In his experience all materials give linear flow-curves if high enough stresses are used and he was sceptical about the existence of sharply defined yield-values.

Commander Goodeve, in discussing thixotropic systems, pointed out that the properties of materials are changed by shearing them, and flow-curves for fully broken-down and completely rested materials cannot be obtained. He explained his "coefficient of thixotropy" and discussed its relation to mobility and yield-value. Dr. Scott Blair stressed the difficulty experienced by rheologists engaged in war-work in getting experimental instruments made when required in small numbers. The intermediate stage between the home-made apparatus and the catalogued standard article was most difficult to bridge. He appealed to instrument makers for help in this matter. Mr. Thomas discussed the rheology of plastic insulating materials and criticized the use of the Martens' test, which he regarded as unsound. Mr. Tayar asked whether the use of an eccentric inner cup in a rotation instrument to prevent "channelling" or slipping was sound in principle.

Dr. White considered that there were many instrument giving useful practical results which were not above reproach on theoretical grounds and that the instrument referred to might be little or no worse than many others. He suggested that the use of integral equations might be of great benefit to rheology. Mr. Plesch stressed the importance of differentiating the degrees of accuracy needed for different instruments. Rheological apparatus used in industry differed widely in this respect. Dr. Wearmouth discussed the rheology of plastics studied over a wide range of temperature, about 200° C. At some temperatures some of these materials showed well-marked yield-values, whereas at others, and often over a wide temperature range, there were no yield-values or the yield-values behaved in a quite erratic manner. The industry wanted a single instrument, if possible, to cover the whole field of behaviour.

Dr. Whitehead, in closing the discussion, pointed out the analogy with the problem of dielectrics and discussed the Hopkinson superimposition principle. He also supported Dr. White's stressing of the importance of integral equations. He mentioned the importance of considering the energy aspects of rheological phenomena and added that he felt that British rheologists were at a disadvantage as a result of the lack of adequate journals for applied physics in Great Britain.

PROTECTIVE MULTIPLE EARTHING

IN 1941 the Council of the Institution of Electrical Engineers set up a special committee to consider the problems arising from the increasing use of multiple earthing of the neutral conductor in factories and other buildings, and the report of the committee has now been published (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 19; July, 1942). The report describes briefly the earthing protective methods generally employed in urban and rural areas and in cities, their advantages and disadvantages. Where underground cables are used, the sheathing and armouring of the cables are employed as the earth return path; alternatively, where available, continuous water mains with metal-to-metal joints may serve the purpose. Where neither of these is available, a separate earth electrode can be used at the consumer's premises although often the cost of an efficient earth is disproportionate to that of the electrical installation itself. Another method utilizes the supply company's low-voltage insulated neutral conductor, connexion being made thereto of each consumer's earth-continuity conductor.

Protective multiple earthing consists of the last-mentioned method, with the addition of multiple connexions of the neutral conductor to earth at other positions on the low-voltage network, and of a connexion between the neutral conductor and earth at each consumer's premises; the earth continuity wire may be dispensed with but this is not recommended. Finally, miniature circuit breakers responsive to very small leakage currents are used.

The Committee's recommendations are as follows: (1) In areas where the supply authority's distribution network consists of underground cables, there should not be any relaxation, other than that contained in Regulation 4, of the Electricity Supply Regulations (1937), which requires earthing at one point only. (2) In areas where the supply authority's overhead distribution system is at low or medium voltage, and where it can be ensured that the distribution network and the consumers' installations are under the same control, so far as the earthing arrangements are concerned, protective multiple earthing would provide a satisfactory alternative to existing methods, and might be permitted. (3) Where the supply is separate from the supply authority's distribution network (that is, where a double-wound transformer or private generating plant is used), a multiple-earthed neutral conductor might be permitted subject to specific conditions being imposed to provide against the risk of interference and possible damage to telephone circuits and apparatus, of gas pipes normally carrying current, of water pipes carrying anything but short-duration fault currents, and of light lead sheaths of telephone cables carrying power currents; these and other contingencies are outlined in an appendix.

Three appendixes are given: (*a*) use of a multiple-earthed neutral conductor where the supply is separate from the supply authority's distribution network; (*b*) protective devices responsive to very small leakage currents and actuating circuit breakers on the consumer's premises; and (*c*) definition of "connected with earth".

The report was submitted to the Electricity Commissioners, who expressed the following views. When protective multiple earthing is adopted, all consumers' installations should comply with conditions as to earthing on the lines of those recommended in Technical Report *F/T* No. 122 (1940) of the British Electrical and Allied Industries Research Association; in the case of consumers' installations existing at the date of adoption of such earthing, the responsibility for the installation complying with the conditions should rest upon the electricity undertakers. It would appear that the Wiring Regulations (Nucleus) Committee takes the view that there should be a continuing responsibility on the undertakers in respect of the condition of the consumer's installation, and if this be the case, the Commissioners in making regulations concerning protective multiple earthing will consider carefully to what extent they could properly impose such responsibility on the undertakers. The Commissioners are of the opinion that it is better, in view of the possible danger which the Committee has pointed out, that the earth connexion on live circuits should not be broken, and that no variation in practice in this respect should be made depending on the voltage of the circuit. They have decided, therefore, to make an appropriate amendment of Regulation 4 (iv) of the Electricity Supply Regulations (1937) on the lines of that suggested by the Committee, when a suitable opportunity occurs. When, on the grounds of cost or convenience, a link is not included in the earth connexion, the use of a suitably designed 'clip-on' ammeter should enable leakage tests to be carried out on live circuits without interrupting the connexion with earth.

FORTHCOMING EVENTS

Friday, September 4

ASSOCIATION OF SCIENTIFIC WORKERS (at Caxton Hall, Westminster, London, S.W.1), at 7 p.m.—Open meeting to discuss and support proposals for a Central Scientific and Technical Board. (The speakers will include Lord Strabolgi.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

UNIVERSITY CHAIR OF CHEMISTRY, tenable at the Royal Cancer Hospital—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (September 1).

JUNIOR EDUCATIONAL PSYCHOLOGIST at the Child Guidance Centre of the Nottingham Education Committee—The Senior Medical Officer, 28 Chaucer Street, Nottingham (September 2).

ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (September 7).

REGIUS PROFESSOR OF ENGINEERING at Edinburgh University—The Private Secretary, Scottish Office, Fieldon House, 10 Great College Street, London, S.W.1 (September 7).

HEAD OF THE CHEMISTRY DEPARTMENT—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (September 12).

HARRIS CHAIR OF PHYSICS, University College, Dundee—The Secretary, The University, St. Andrews (December 31).

LECTURERS AND INSTRUCTORS FOR TRAINING RADIO MECHANICS—The Principal, College of Technology and Arts, Eastlands, Rugby.

TEACHER FOR DAY AND EVENING ENGINEERING CLASSES—The Principal, County Technical College, Gainsborough, Lincs.

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PRESERVATION OF OXFORD

WHILE it is recognized that without some measure of central direction and regional guidance there can be no re-planning and reconstruction of our towns or countryside which will ensure the best use of the nation's reserves of land, the right balance between industry and agriculture, between work and leisure, that is, the best from the point of view of social and cultural as well as material needs, it is in the application of the planning principles and policy to particular local problems that the individual citizen is most interested. Those are the consequences that are likely to provoke his most speedy reaction, and his support of, or opposition to, any Ministry of Planning. He will judge of its value by the results that he can see in the district most familiar to him.

On that ground the report of the Committee on Planning and Reconstruction appointed in November 1940 by the Oxford Preservation Trust is indeed of more than local interest. The second part of the report which has now been issued (see page 297) deals with questions directly related to the old University City of Oxford, and includes a summary of the conclusions presented in April 1941 in the first part of the report, which was concerned with planning for the Oxford region and how far the measures that are necessary locally are dependent on national action. But the national interest of the second part of the report is actually scarcely less than that of the first part, in spite of its narrow scope, and the announcement of the endowment of a chair of social medicine at Oxford by the Nuffield Trust gives a sufficient clue to the fundamental reason.

The report gives a good historical sketch of the changes in Oxford in the last generation and of the acute problems which continued development presents. The evils described still remain and may be greatly intensified in the future. Indeed, the unique character of the Universities of Oxford and Cambridge is something worth cherishing and worth defending as a national rather than as a local inheritance only. It would be a national disaster and no mere local tragedy if we allowed rapid and uncontrolled industrial development to thwart either the growth of the university in such directions as Nuffield College has stimulated or the remoulding of the City of Oxford itself and its preservation from the sordid encroachments that have been allowed to sully it.

No city, in fact, has a greater duty and a greater opportunity than Oxford to take a leading part in the movement to remould social conditions and to add fresh splendours of architecture, new beauties of park and garden and spacious emplacement to our heritage. The study that has already been given to the physical planning of town and country has eased the way, and the times are favourable, not only for taking further preventive measures to safeguard the University and City from further detriment, but also to remedy, so far as practicable, the injuries already suffered, as well as to adopt a broad constructive policy for the future. The report outlines a complete scheme for the preservation and ordered development of Oxford, undeterred by doubts as to its financial feasibility. It recognizes the need for careful consideration of existing interests—that a city is not a mere collection of buildings with services of roads, light, water and the rest. With its emphasis on the community and its individual and social needs, it advances a plan bold and comprehensive enough to command wide approval.

The report points out that it is almost impossible to forecast what may be the extent and nature of future developments in the University, and it is of the utmost importance therefore that a generous view should be taken of the need there may be for expansion on the part of the University and the colleges. Through lack of foresight and collaboration, they have made not a few mistakes in the past, and the University can already provide examples of the consequences of defective planning. Moreover, the tendency noted in recent years for research institutes to seek establishment in Oxford may develop very greatly after the War; and should the number of university students even equal that at Cambridge, much fresh building would be required for their accommodation. It is doubtful whether it has been sufficiently considered how many new sites of liberal extent may be required if, after the War, Oxford were to prove, as it well might, a far more powerful magnet for the attraction of specialists and students from all over the world than it has in the past.

The splendid new facilities for bringing research into contact with the problems of medicine and of social and economic organization made possible by Lord Nuffield's benefactions are a pointer in this direction which should not be overlooked any more than their implications for civic development. The University of Oxford is no longer an institution catering for only one section of the nation. At least half its students are drawn from the less wealthy classes of the community. Its teaching and research embrace the social sciences, and members of the University have proved themselves as leaders in many departments of the national life. Moreover, just as the welfare and environment of the University is not a matter of merely local concern, so the embellishment of the City of Oxford with a civic centre and other developments recommended in the report to rescue it from its present disfigurements, and with the new features that are proposed, and adequate hotel accommodation, should lead to an even greater number of visitors to Oxford, with much financial benefit to the catering and other trades of the city. Its proximity to Stratford-on-Avon would help to make the district one of the principal centres for visitors from the Continent, the Dominions and Colonies and the United States.

In regard to industry, the report concludes that the industries now established should not be subjected to any harassing restrictions, but every effort should be made to serve their welfare. On account of the historic character of Oxford, any tendency to develop it into a great industrial city is to be deprecated and should be forestalled. No heavy industries should be permitted to establish themselves and no sporadic industrial expansion should be allowed. Certain facilities should be given for the establishment of additional light industries, and any proposal that might be made for creating an industrial estate for this purpose should be considered sympathetically. The most valuable location for such an estate would be in the neighbourhood of Cowley, on land already zoned for industry in the Mid-Oxfordshire Planning Scheme.

According to the report, there are strong reasons for an entirely new departure in connexion with a civic centre. Such a centre should be designed so as to meet all the requirements of a modern municipality, and the error of cramping the site and leaving no room for future developments, committed by so many of our towns, should not be repeated here. Again, in regard to housing, the report stresses the importance of making sufficient provision for social needs in planning all new housing estates.

The committee has wisely included as an annexe to its report a report of the Oxford City Council's proceedings on the plan for redevelopment, which indicates the measure in which the Oxford Preservation Trust's proposals are likely to find local support. What emerges from this report is, in fact, the extent to which local opinion is ahead rather than behind Government action, and the general impatience at the slow progress under the Ministry of Works and Planning. This is notably true of several of the badly damaged towns which, following the example of Coventry, have been quick to realize the opportunities now to their hand for redressing past mistakes and errors.

The procedure suggested in the report is that the Oxford City Council—in conjunction with the two neighbouring County Councils, if they concur—might approach Parliament with a view to the passage of a special Act, for the establishment of a statutory commission to carry out such improvement scheme as might be adopted. The City Council should have the right to nominate a majority of the members of such a commission, on which both the County Councils of Oxfordshire and Berkshire as well as the University would be duly represented. The commission would have executive powers to carry out schemes in co-operation with the local authority concerned. Such a plan would avoid difficulties and delays which would otherwise occur from existing local boundaries, and would enable new financial sources to be tapped while protecting local interests. Any special powers for the acquisition of land could be embodied in the Act.

The broad outlines sketched above of the scheme for the re-planning of Oxford and its environs put forward by the Oxford Preservation Trust will serve to indicate the active interest which is being shown in the future utilization of the countryside of Great Britain. It is typical of many local efforts, which when integrated should make of the country a better place—a place in which both cultural and material needs are duly considered. The Ministry of Works and Planning must see that this local interest is fostered and, where necessary, guided to serve the needs of the country as a whole.

GOETHE'S SCIENCE

Goethe on Nature and on Science

By Sir Charles Sherrington. (The Philip Maurice Deneke Lecture, delivered at Lady Margaret Hall, Oxford, on the 4th March, 1942.) Pp. 32. (Cambridge: At the University Press, 1942.) 1*s*. 6*d*. net.

GOETHE is the only considerable poet who devoted much of his time to science and who took himself seriously as a man of science. Make no mistake, he took himself very seriously: he said, for example, to Eckermann, "I do not attach importance to my work as a poet, but I do claim to be alone in my time in apprehending the true nature of colour". Although he might on consideration have tended to revise this estimate of his poetry, it is abundantly clear from other records that he was convinced of the lasting importance of his writings on colour. Shelley took at one time a close interest in chemical experiments; Beddoes, a lesser, but not inconsiderable poet, spent most of his time in anatomical study, but neither of them thought that he had made a substantial contribution to science. Goethe stands alone.

Goethe invented the term 'morphology' and left sufficient mark in this study for him to be quoted more than once in D'Arcy Thompson's great work, "Growth and Form", in particular his aphorism "Das lebendige ist zwar in Elemente zerlegt, aber man kann es aus diesen nicht wieder zusammenstellen und beleben". His wide view of Nature as a living whole led him to make certain shrewd generalizations in the biological field which, while they have failed to win support, still retain an interest, but even in biology the one concrete discovery generally attributed to him, namely that of the intermaxillary bone in the human skull, was not new, having, as is pointed out in the study before us, been anticipated by Vicq-d'Azyr. It was to his investigations and speculations in colour, however, that he was particularly attached, and here his misunderstandings were so fundamental that the "Farbenlehre" has long been a puzzle to physicists, who have been unable to find a consistent or remotely reasonable point of view in it.

Goethe took as his fundamental phenomena those exhibited by light in passing through turbid media, such as colloidal suspensions; for example, that produced by adding a few drops of spirit varnish to water. Unfortunately, scattering phenomena are singularly ill-suited to serve as a starting-point for investigations or speculations on the fundamental physical properties of light and colour. No doubt Goethe was led to give them the foremost place in his teaching because colours due to scattering are particularly common in outdoor Nature, as exemplified by the red sun seen through fog or mist, the colour of distant hills and various phenomena in water containing suspended particles. It is also possibe that he may have been stimulated by de la Hire, who, about a hundred years earlier, put forward views rather similar to his own.

Goethe was an acute observer, and his descriptions of the colours due to scattering are numerous and precise. He attached, however, great importance to the background in observing the blue colour due to light scattered sideways, insisting that it should be black, since black played a great part in his theory. Although, of course, a black background makes observation easier, it is of no fundamental significance. This question of background is exemplified, for example, when, in explaining the colour of the sky, he says, "If the darkness of infinite space is seen through atmospheric vapours illuminated by daylight, the blue colour appears", which is, in a way, an anticipation of the true explanation of the colour of the sky, afterwards given by Rayleigh.* Goethe did understand that the blue of the sky was analogous to the blue of a beam of light in a colloidal solution.

How Goethe endeavoured to wring an explanation of all colours, including those of the prismatic spectrum, from the colours exhibited by scattering media is a long and complicated story of uncritical effort and obstinate misunderstanding. Whenever he was describing what he saw, however, he was clear and accurate, as in his talk of after-images and of simultaneous and successive contrasts. Physicists have been rather unjust to his descriptions of scattering phenomena, which were not properly understood before Rayleigh's fundamental work, and so certainly not by Goethe's early critics. He alienated men of science by his senseless and absurd attacks on Newton, whose point of view—that is, the modern scientific point of view—he was utterly unable to comprehend. He objected to mathematics as something that concealed the truths of Nature, and his ignorance and distrust of the quantitative often led him astray. In one experiment of his, for example, he objected that the red and the blue were not separated, which on Newton's theory they should be. Certainly they should, but a simple calculation shows that the angle between the red and blue ray should be only about a minute of arc, which he could not observe.

Goethe's antipathy to Newton's teaching led him to most ridiculous lengths: he not only accused Newton of deliberately misleading his readers, of "advocates' dodges" and "conjuring tricks", but even called him "a Cossack Hetman"—surely the most inappropriate term of abuse ever used. The very things on which Newton laid emphasis, precise quantitative experiment under carefully controlled conditions, were obnoxious to Goethe, who wanted to observe colours as they occurred in Nature. Newton probably seemed to him something like a Shakespeare critic who should try to explain the beauty and greatness of the poet's work by counting the frequency of occurrence of certain words, or investigating derivations. One does not find the essence of poetry by mathematics.

We are confronted with the question as to how a man of such mental power, vision and industry as Goethe could devote so much time to the problems of science without leaving any mark in the history of science, without being more, so far as his work on colour is concerned, than a psychological curiosity. Towards a solution of this question, which has been much discussed, especially by German writers, Sherrington's slender booklet contributes more than many ponderous works have done. The author is, of course, peculiarly fitted for his task. Not only is he one of the very greatest scientific figures of modern times, but also he is a poet of extreme sensitiveness, grace and perception, a man of profound knowledge and wide sympathies, a scholar, a linguist and, above all, a man of deep human understanding. What has he to tell us?

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*"M. de la Hire says that the air, which is made white by the rays of the sun, appears blue on account of the black ground of the unenlightened space beyond it". Priestley, "History of Optics", 1772.

He points out that Goethe was a man with a very peculiar and personal view of Nature (not nature) and a man for whom sight was the predominant sense. He thought that Nature was not to be understood by the analysis of the laboratory and the mathematician's desk, but only by concentrating attention on certain *Ur-phänomena*, or bed-rock phenomena—sometimes Goethe speaks of *Grund-phänomena*—which were of especial significance and were open to direct observation. In colour the scattering phenomena (not, of course, so called by Goethe) were fundamental: we always see through media, more or less cloudy, and so the colours which cloudy media produce are of basic importance. In botany he attached great value to the conception of an ideal leaf which his highly personalized Nature always kept in mind. In the animal world she always had an ideal type before her: an advantageous departure from the type in one direction had to be counterbalanced by a disadvantage in some other direction. For Goethe, to attempt to understand Nature was to attempt to understand a personality, a divine personality if you will, but one taking an almost human delight in creation and device. In Sherrington's words: "For him, surely, the Nature he turned to, and addressed so often, was no impersonal principle, no causal concatenation of material forces. Rather, it was a numinous presence, immanent in Earth and Sky, operating the gates of birth and death."

This short thesis, every sentence of which is significant, really does lend a new meaning to Goethe's scientific work and shows it to be the product of a point of view which is consistent, even if utterly removed from that of modern science, as created by Newton. Goethe's labours in science have borne little fruit, but knowledge of them throws a strong light on the character and mode of thought of one who is undoubtedly among the few great writers of all time. The booklet which is now before us not only helps us to understand Goethe but also, which is just as important, to understand Sherrington. It will bring delight to all his admirers, that is to say, to all who know him or know anything of his work, for it shows the master still writing with all the clear imagery and vivid analysis, with all the generous emotion and keenness of perception which have at all times mitigated the severity of his scientific thought.

E. N. DA C. ANDRADE.

PROGRESS IN PHYSIOLOGY

Annual Review of Physiology

James Murray Luck, Editor; Victor E. Hall, Associate Editor. Vol. 4. (Published by the American Physiological Society and Annual Reviews, Inc.) Pp. viii+709. (Stanford University P.O., Calif.: Annual Reviews, Inc., 1942.) 5 dollars.

DESPITE the "ever-narrowing confines of the world in which we can enjoy the friendly intimacies of intellectual collaboration", to which the editors allude in their preface, the present volume is larger than most of its predecessors. One notes that the contents, always predominantly dealing with American work, are now almost entirely American except for references to a few pre-war papers. There is no ground for surprise in this; the numbers of investigators engaged in physiological research is far greater in the United States than elsewhere, at any time, and during the past three years one European country after another has closed down publication. Some of the contributors are more aware than others of work published outside the United States, while some appear to be quite unaware of non-American work; in any event it is unquestionably far outweighed by the large bulk of American work.

The volume contains references to nearly four thousand original papers, and to about the same number of authors' names: the task of selecting these from the enormous bulk of contemporary literature must have been enormous and thankless, though, of course, there is great variability in the available numbers of papers relating to the different reviews. The largest number no doubt are those papers that refer to the physiology of reproduction, and this review, by F. L. Hisaw and E. B. Astwood lists 486 references: in a relatively restricted field such as in the review on the physiological effects of neutron rays, by P. C. Aebersold and J. H. Lawrence, only thirty-one references are given. It is probable that reviews covering more restricted fields, such as that one, are able to quote a larger fraction of the published work than are the ones dealing with richer bibliographical resources. Further, the treatment in such reviews has the opportunity to cover its ground in a more leisurely and thorough manner, and so to be more generally instructive than that of the harrassed and overcrowded branches of the subject.

It would be difficult to pick out any of the reviews for detailed comment, since each is itself a condensation of so much. But one of them did impress the present writer by its originality, and by its suggestion of a new method of approach to physiological problems. This was the article on physiological psychology by Curt P. Richter. It deals with total self-regulatory functions in their relationship to Claude Bernard's concept of the maintenance of a constant internal environment. This constancy is attained not merely by partial physiological responses, but also by behaviour or total organism responses. For example, adrenalectomized rats will, if able, consume enough salt to keep themselves free of symptoms of adrenal insufficiency; diabetic rats took fat and rejected carbohydrate, and so on. After section of the taste nerves, adrenalectomized rats failed to distinguish between water and salt solutions. This behaviour drive opens up a method for the determination of metabolic needs, on the basis of "a little of what you fancy does you good", and instances of markedly unusual behaviour observed clinically may be considered as an expression of the drive to maintain a constant internal environment.

Another useful article is one on applied physiology, by Lieut.-Commander A. R. Behnke, U.S.N., and Captain C. S. Stephenson, U.S.N. This deals largely with various services problems, such as those connected with aviation, diving, submarines, etc. It is realized in the United States that "A prime need in the military service is the application of physiologic knowledge to field practice", and it is also acknowledged that in Germany this is realized to the full. In Germany, for the past five years, some twenty Government-supported laboratories were equipped with low-pressure apparatus for research in military flying, whereas for the same period the United States had only one physiological laboratory engaged in such work. This is a hint that might well be taken in Great Britain, in which the value of physiology is little recognized, perhaps on account of political repercussions connected with the question of experiments on animals.

A mere list of the remaining articles must suffice, able and authoritative though these be. They are permeability, by L. R. Blinks; physiological aspects of genetics, by H. H. Strandskov; developmental physiology, by H. L. Hamilton and B. H. Willier; water metabolism, by J. P. Peters; growth, by G. S. Avery; energy metabolism, by W. H. Chambers, E. Shorr and S. B. Barker; the physiology of the skin, by P. C. Baird, jun., W. F. Lever, and T. D. Spies; the peripheral circulation, by A. P. Hertzman; heart, by M. B. Visscher; blood, by H. P. Smith; the digestive system, by E. J. Van Liere; kidney, by J. A. Shannon; electrophysiology, by R. W. Gerard; the spinal cord and reflex action, by T. C. Ruch; the central nervous system, by M. Hines; the autonomic nervous system, by K. Hare and J. C. Hinsey; sense organs, by H. K. Hartline; metabolic functions of the endocrine glands, by C. N. H. Long; and the pharmacology of drug addiction, by M. I. Smith.

The index is good and extensive, and the type and paper pleasing.

It would be a good feature in future editions if a bibliography of published books and monographs on physiology and cognate subjects for the year could be included as a special appendix. This would be of especial value at the present time, when so many are cut off from sources of information as to new publications.

C. LOVATT EVANS.

CELL RESPIRATION

A Symposium on Respiratory Enzymes

Contributors: Otto Meyerhof, Eric G. Ball, Fritz Lipmann, Kurt G. Stern, Fritz Schlenk, T. R. Hogness, Elmer Stotz, Carl F. Cori, E. A. Evans, Jr., Philip P. Cohen, K. A. C. Elliott, Dean Burk, C. J. Kensler, Erwin Haas, H. M. Kalckar, M. J. Johnson, Van R. Potter, H. G. Wood, R. H. Burris, C. H. Werkman, P. W. Wilson, F. F. Nord, Ephraim Shorr, A. E. Axelrod, Frederick Bernheim, E. S. G. Barron, Frederick J. Stare. Pp. xii+281. (Madison, Wis.: University of Wisconsin Press, 1942). 3 dollars.

IT has been said by Sir Frederick Gowland Hopkins that among the most fundamental of the dynamic chemical events related to life are the oxidations which yield energy to the cell. The study of the mechanism of cell oxidations does indeed seem to be developing into a main route to the understanding of the biochemical basis of life processes. This explains why so many biochemists are now devoting their energies to these problems, as the flood of individual publications shows. But whereas there are numerous excellent compilations on other similar fields, such as the vitamins, for example, collected opinions on respiratory mechanisms are comparatively few, and mostly the published accounts have been presented in support of one particular point of view.

The University of Wisconsin is therefore to be congratulated on having made a highly successful venture to fill this gap. With the University of Chicago, it inaugurated on September 11–17, 1941, a conference to consider the respiratory enzymes and the biological action of the vitamins. The lectures and discussions on respiratory enzymes given at Wisconsin have now been published in book form, and may be cordially recommended as a valuable guide to the present state of knowledge in this highly complex field. It is worth mentioning that no less than twenty-seven main contributors take part, almost all Americans or those for whose presence the scientific life of the United States is the richer and that of Germany the poorer. All are scientific workers of distinction in this field. This is not necessarily a guarantee of a successful symposium; but in this case the combination leaves little to be desired. Whether due to the genial atmosphere of Wisconsin, or to skilful though anonymous editing, the views of the various contributors are expressed with conspicuous clarity and forthrightness, and the text, not being encumbered with experimental or mathematical detail, is most readable. Sometimes the contributions overlap a good deal; this would be very irritating in a text-book, but this is essentially a book for the research worker and advanced student, and such are more likely to be inspired by its enthusiasm than put off by its lack of continuity in presentation.

On the whole it is rather surprising to find so much agreement on fundamentals. This would have been unthinkable only fifteen or twenty years ago, and is an indication that the subject of tissue oxidations is growing up, and leaving behind the controversial and uncertain. The points now at issue are for the most part concerned with the relative importance to be given to various alternatives, rather than with factual disputes. Much of this clarity is due to the application of physicochemical methods. E. G. Ball, of Harvard, gives a valuable review of the cytochrome-oxidase cytochrome system, and shows how the energy of oxidation instead of being explosively liberated is released in a series of at least six steps, the amount at each stage corresponding with the oxidation-reduction potential of the particular enzyme system concerned. Not only these potentials (except that of cytochrome oxidase) but also the amounts of the various catalysts in different cells and tissues are now known. Dr. Ball charts these potentials and gives an ingenious theory of respiratory poisons. Final elucidation seems to await the isolation of all components, particularly of cytochrome *b* and cytochrome oxidase, which it is necessary to remind ourselves are as yet available merely as crude suspensions of ground-up tissues. In later chapters E. Stotz discusses the detailed properties of the cytochromes, and K. G. Stern gives an excellent comprehensive account of oxidases, peroxidases and catalases. Among outstanding controversial issues needing clarification, is the question of the indispensibility claimed by some workers for the presence of oxygen for catalase activity, which is well reviewed by Stern. In other chapters the Pasteur effect is constructively discussed by F. Lipmann, and the individual nicotinamide and flavoprotein systems are described; T. R. Hogness gives an account of the important link between the single-electron cytochrome systems and the two-electron reduction of the nicotinamide coenzymes which is provided by the flavoproteins, particularly by cytochrome *c* reductase. These compounds seem to be able to do this by virtue of their semiquinone formation.

Metabolic cycles always seem to give trouble. It is noteworthy that the Szent-Györgyi system of hydrogen transport, which until recently occupied a commanding position in all discussions, has to some extent receded into the background. In the first place, rival schemes, particularly the Krebs citric acid cycle and the discovery of carbon dioxide fixation in pyruvate metabolism, seem to have provided new and attractive alternative interpretations of some of the basic experiments of Szent-Györgyi, although Krebs himself has upheld the importance of this system. Secondly, hydrogen transport to the cytochrome system is now considered possible directly via flavoprotein from several intermediate metabolites, so that the same insistence on the essential transport by the succinate system does not seem to be regarded as necessary. A highly critical attitude towards the 4-carbon acid system is often noticeable, particularly by Hogness (p. 143) and Ball (p. 35); the latter rejects entirely as "a blind alley" the inclusion of the malate-oxaloacetate system into Szent-Györgyi's scheme. Whether the Krebs cycle really includes citric acid, or rather *iso*citric acid or some other intermediate is also debated. The application to bacterial metabolism of these cycles, and the importance in bacteria of carbon dioxide fixation, are discussed in valuable contributions from H. G. Wood and C. H. Werkman.

How, and to what extent, is this energy harnessed for use by the living cell ? The positive evidence in this most difficult question seems to be limited to the part played by coupled phosphorylations, as exemplified by the obligatory coupling between the oxidation of triose and the phosphorylation of adenosine diphosphate. H. M. Kalkar and C. F. Cori individually discuss these and related problems. The latter shows how the phosphorylation of glucose depends on the aerobic formation of energy-rich phosphate bonds during the simultaneous oxidation of substances such as pyruvic, fumaric and succinic acids. The glucose so phosphorylated is now capable of breakdown to triosephosphate and pyruvate, and thus the cycle of glucose oxidation continues. In reviewing these important mechanisms, Cori directs attention to the fact that in the intact cell regulatory arrangements must exist integrating these activities; such regulators may well include many hormones, substances which do not themselves appear to be essential constituents of any enzyme system, but which may perhaps soon be fitted into this fascinating story. Another example of aerobic phosphorylation is provided by F. Lipmann, who shows that in the bacterial oxidation of pyruvate the highly unstable acetylphosphate may be isolated as the silver compound. Otto Meyerhof, now of the University of Pennsylvania, contributes a stimulating introductory article on intermediary metabolism, which includes numerous valuable suggestions for present-day attack.

Space does not permit more than a passing reference to the discussion on tumour metabolism : the reviewer is here on delicate ground, for the phrase "most authors agree . . ." which occurs several times in this chapter is perhaps an over-statement. But this section is worthy of serious study, and the pessimism of K. A. C. Elliott is well offset by the exuberance of Dean Burk. The latter boldly challenges all and sundry that he will diagnose tumour growth from its metabolism correctly in well over 95 per cent of cases, but perhaps this estimate of the accuracy may be lowered if many more normal tissues with "cancer-like metabolism" are discovered, and several are already known. No one seems to have given much attention in this section to the possible connexion between aerobic glycolysis and insufficient oxygenation *in vivo*, although Lipmann in his discussion on the Pasteur reaction has done so, and this may in the reviewer's opinion be as important a factor in tumours as it is believed to be in other tissues with aerobic glycolysis, such as cartilage, medulla of kidney, and intestinal mucous membrane.

Although there is much about carbohydrate oxidation and something about amino-acid oxidation in this book, the oxidation mechanisms which deal with fats, aceto-acetic acid and fatty acids are scarcely referred to at all.

The text is enlivened by numerous "candid" photographs of the participants. The general production is excellent.

F. DICKENS.

A RUSSIAN-ENGLISH DICTIONARY

New Complete Russian-English Dictionary (New Orthography)

Edited by Dr. Louis Segal. Pp. xii+965. (London : Percy Lund, Humphries and Co., Ltd., 1942.) 42*s*.

THE making of dictionaries is an evolutionary process; each new dictionary has or claims to have certain advantages over its predecessors that justify its appearance in the competitive struggle for existence, while the greater part of the reading matter must necessarily remain unchanged. The most obvious merit of Dr. Segal's dictionary, in comparison with earlier Russian dictionaries, is the clearness of the type; this is a most pleasing improvement. The use of the new orthography is an inevitable development which will be welcomed by the ever-increasing number of those who are unacquainted with the old, and the accenting of the Russian words will also be a help to the average English user.

A characteristic of many of the older Russian-English dictionaries is the frequent use of obsolete English words, as though the compiler (usually a Russian) of the dictionary was himself unacquainted with the evolution of the English language in the last two centuries and had slavishly copied earlier lexicographers whenever a difficulty or doubt as to the meaning of a word had arisen. It must be admitted that this most recent dictionary displays the same characteristic of archaism, the origin of which can easily be traced to earlier dictionaries, particularly Alexandrov's, to which the author acknowledges his indebtedness, and in which identical archaisms occur. Words like "eliquation" and "prase" defeated both the reviewer and the "Concise Oxford Dictionary"; one finds words such as "tetraphyllous" where "four-leaved" would obviously have been better, and so far at least as agriculture is concerned some of the translations betray a certain limitation on the compiler's knowledge of English agricultural terminology. Taking the dictionary as a whole, these are quite minor defects; the point is that they all occurred in the old, pre-Revolution dictionaries and have been incorporated unamended into the new. On the other hand, the translated idioms have been considerably increased in number (in comparison with the older dictionaries) and have been brought up to date.

It would have been advantageous to the majority of English students of Russian to have had some simple guide to the conjugation of verbs included in the brief section on grammar at the beginning. This is a part which might profitably be extended in a subsequent edition.

FIRST SIR JOSEPH J. THOMSON MEMORIAL LECTURE

WITHIN the generous curve of Faraday's horseshoe table at the Royal Institution, almost every distinguished man of science has stood, at some time or another during the last hundred odd years, to deliver a "Friday Evening", or some other discourse. Some have been grim, and some have been gay, but none have been both in perhaps quite the same sense as Sir Joseph John Thomson.

The recent memorial lecture, under the auspices of the Chemical Society, given on April 16 from the same spot by the son of his predecessor in the Cavendish chair at Cambridge, is no ordinary tribute. Lord Rayleigh has produced something at once personal and vivacious, but at the same time historical. Three parts, very unequal in length, but all valuable, may be discerned. The first is biographical and completely charming. (Who can possibly forget 'J. J.' pushing his glasses up on to his forehead to look at something close at hand ?) The second is, in effect, largely an account of the search for the electron, and contrives to make the period 1870–1905 live again in retrospect. The third and shortest, depicts 'J. J.' as Master of Trinity. Many perhaps will wish that it had been longer, but for all that, one is glad to have it just as it is.

Our task now, however, is to meditate afresh upon the thirty-five years of activity to which Lord Rayleigh devotes the bulk of his address. Nevertheless, it is scarcely feasible to do this, without first of all recognizing the extraordinary intellectual strength possessed by the Cavendish professor. This characteristic is well brought out ; day after day he would go his rounds of some three dozen research students, hearing their individual troubles and setbacks, but ready almost immediately with counsel and answer to their problems. Lord Morley once remarked, "Never say never"; certainly tradition has it that 'J. J.' never required any "notice of that question". Doubtless, in such an atmosphere as this came into being the powers of the Cavendish Laboratory—and all that it stands for, even apparent neglect not excepted—to train men for research.

Lord Rayleigh deliberately limits himself to discussing the era already indicated ; but more than this, he bids us look at it with the eyes of those who were in it and about it. This is most salutary. At once, the value of such an approach is manifest, for it enables the great controversy of the times concerning the nature of cathode rays (corpuscular or wave-like ?) to be apprehended as it appeared to contemporary thought. Since then, there has been much uncertainty, both in principle and in detail. But in those days, nothing blurred the sharp outline which divided the two schools. Cathode rays had to be one thing or the other.

There seems little doubt that what imparted the initial impulse to these investigations was the feeling that in a highly rarefied gas conditions were likely to be less complex than in liquids and solids. The kinetic theory, too, was at hand to help in getting a clear view in the mind's eye of what exactly was happening. Hittorf apparently was the first to observe phosphorescence around the cathode. Meanwhile, broadly the British school—Varley, Crookes, Kelvin, to whom should be added George Francis Fitzgerald—upheld the corpuscular theory, whereas Lenard, Hertz and others on the Continent supported the wave-nature interpretation. Lenard showed that cathode rays could penetrate a thin aluminium window. This was something of a reverse for the corpuscular upholders, but Thomson inclined to the opinion, Lord Rayleigh says, that an explanation might be found in the generation of a derived stream of particles on the far side. In 1895 Perrin performed his well-known experiment (somewhat akin to Faraday's ice-pail) and Thomson made a crucial extension to it. In these ways it appeared inescapable that cathode rays were in fact transporting negative electricity, and were thus essentially particles. The final stages, leading up to (m/e), need no recapitulation here.

It is noteworthy that Thomson was always somewhat attracted by the border-country between physics and chemistry ; indeed a dissertation having a strong sympathy in that direction won him his fellowship at the first attempt. Seen at this angle, it is more than fitting that such a lecture as we are now considering should have materialized under the ægis of the Chemical Society. Perhaps with this in view, Lord Rayleigh dwells almost exclusively upon his subject's distinction as an experimenter. But Thomson's contributions to mathematical physics were no less remarkable ; for example, the discovery in the early 'nineties of electromagnetic momentum. In this may be seen a pre-condition for the rise of the great edifice in recent years, associated particularly with the names of Born and Dirac. Altogether, truly a momentous achievement. Then in 1918, on the advice tendered by Mr. Lloyd George to the Crown, 'J. J.' left the Cavendish for Trinity Lodge, there to gain new affections and new triumphs of a different kind ; and so it was, until the end came on August 30, 1940, in his eighty-fifth year.

F. IAN G. RAWLINS.

CYTOLOGICAL CRITERIA OF MAMMALIAN ENDOCRINE ACTIVITY

By C. L. FOSTER

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A CONSIDERATION of the development of endocrine histology throws considerable light both upon the problems which have confronted the investigator and the way in which attempts have been made to solve them. When the physiological significance of the endocrines was less understood than it is now, their histological descriptions were relatively simple. For example, in the anterior lobe of the pituitary two chromophilic and one chromophobic type of cell were described. As the gland came to be investigated in the light of an increasing knowledge of its physiological activities and with improved techniques, the complexity of the histological picture increased. Transition cells between chromophobe and chromophil have been recognized in many animals investigated[1,2,3], and in the dog[4] dark and light varieties of the basophil cells have been described, as have special carmine acidophils in the cat[5]. In a like manner, the original principal and oxyphil cells of the human parathyroid[6,7] have each been divided into two types—dark and light ; osmiophilic and non-osmiophilic cells have been described in what was originally considered as the uniform parenchyma of the rat parathyroid[8,9], and I[10] have observed a somewhat similar differentiation with intermediate cell types in the mouse. Again, in the human pancreatic islets Gomori[11] has recorded cells intermediate between *A*-cells and the *D*-cells of Bloom, and Hoerr[12] and others have described dark and light cells in the zona reticularis of the adrenal cortex.

The attempts to explain the apparently increased histological and cytological complexity of various endocrines have resulted again in an effort at simplification. The present tendency is to discover whether the apparently different cell types of a gland are not in reality phases of a cycle associated with secretory activity. This concept has focused attention on individual rather than mass cellular changes within the gland, and has opened up what may become a more profitable approach to the subject—that of physiological cytology.

The more specifically cytological attitude to these problems has resulted naturally in a search for reliable criteria of cellular activity. Of these the most obvious were the stainable intracellular granules, such as those of the acidophil and basophil cells of the anterior pituitary, which, largely by analogy with the specific granules of the pancreas and similar exocrine glands, have come to be regarded as prosecretion granules, and hence their density in a cell has been looked upon as a function of its secretory activity. Although this is a reasonable assumption and has so far proved satisfactory as a working hypothesis, there is as yet no histochemical evidence (at any rate for the anterior pituitary among endocrines) to support the identification of the granules with the secretion or its precursor. Somewhat similarly in the adrenal cortex—where there is evidence that the cortical cells originating perhaps from fibroblast-like cells in the capsule move radially through the cortex until they finally become senescent in the zona reticularis[13,14]—variations in the size and concentration of osmiophil droplets in the cells of the different cortical zones have been used as an index of cellular activity[15,16]. Similar correlations might perhaps be made with the phases of development and regression of the corpus luteum[17] in relation to its fat and lipoid content and physiological activity. As is pointed out later, there is some evidence derived from microchemical tests that the lipoid material in the adrenal cortex is in part associated with sterol compounds.

In addition to a consideration of these labile cell contents, interest has been increased in the permanent cell parts such as the mitochondria and the Golgi material. Enough evidence has now been produced to remove any doubts as to their real existence[18,19], but very little of a precise nature is known of their chemical constitution. Various workers have reported the mitochondria as containing, in addition to lipoids (of which there is but little according to Bensley[20]), protein[21], vitamin A[22], vitamin C[23] and glutathione[22]. A possible protein component has also been suggested for the Golgi body[19,24]. What little is known of these cell organelles is at present of little value in elucidating their role in secretory activity, but that the Golgi bodies do have a role is becoming increasingly evident. The topographical relation between the Golgi apparatus and the secretion products is not so clearly established in most endocrine as in exocrine gland cells, but there is some evidence for such a relation in the thyroid gland, where 'pro-colloid' droplets have been recorded in the Golgi area[25,26]. Nevertheless the close topographical association in the pancreatic acinus cell, for example, between the Golgi material and the neutral-red vacuome or prozymogen substance[19,27] has strengthened the concept of a similar relationship between secretory activity and the Golgi body in endocrines as well. Additional suggestive evidence is furnished by (1) Bowen's[18] demonstration that in certain animals the acrosome granule of the sperm originates in a vacuole which is in intimate contact with the Golgi material; (2) the observation of Severinghaus[28] and others[29] that the Golgi area (in anterior pituitary cells, for example) is often vacuolated, and (3) the fact that the walls, or the area in proximity to the walls, of the contractile vacuoles of certain Protista blacken with osmic acid[30].

A marked polarization of the Golgi body is generally a characteristic of exocrine gland cells, this structure being between the nucleus and the surface at which the secretory products are discharged. The only endocrine which shows anything like a fixed polarity is the thyroid, where the body is between the nucleus and the follicular lumen. Since the thyroid is by origin a gut diverticulum, and possibly only secondarily a gland of internal secretion, this is perhaps to be expected. Cowdry[13], however, maintained that the position of the Golgi body was a reliable index of the direction of secretory release, its occasionally reversed position in the guinea pig, for example, being indicative of secretion directly into the capillaries. This may be the case for the thyroid, but there is no satisfactory evidence in support of a fixed capillary polarity in epithelioid glands such as the anterior pituitary and parathyroid, where the observations are conflicting[19], or in the islet tissue or adrenal cortex. Thus the question of the polarity of the Golgi body in endocrines as a whole is at the moment too controversial to be admitted as evidence of its participation in secretory activity.

Since it has been established that in exocrine glands the Golgi body hypertrophies during secretory activity[18]—for example, in the parotid gland—the endocrines have also been examined from the same aspect. Generally speaking, activation results in hypertrophy of the Golgi body. This occurs, for example, in the thyroid gland after the injection of anterior pituitary extracts[32, 33], in pancreatic islet cells after œstrone injection[34], and in the rat parathyroid[35] after the experimental induction of low calcium and low phosphorus rickets respectively. Similarly, there is some evidence to show that inactivation of a gland may result in a shrinkage of the Golgi body; this, for example, has been reported in the rat parathyroid after parathormone injection[8]. Whether, however, Golgi body hypertrophy or its reverse is to be correlated with a corresponding increase or decrease of secretion formation, with secretion release, or with both, is by no means certain.

The anterior lobe of the pituitary gland provides the most satisfactory material for an analysis of this problem, since there are records not only of the state of granulation of the chromophil cells in relation to physiological activity, but also of the condition of the Golgi material. Severinghaus[3], on the basis of the study of human material stained under carefully controlled conditions, has produced evidence to show that, both in acidophil and basophil cells, there is a regular cycle of granule depletion ending in a chromophobic state, followed by a granule accumulation resulting in the restoration of the chromophilic condition. This process continues, presumably, until the cells become senescent. Thus, the state of complete granulation is to be regarded as a phase in a cycle which marks the end of synthesis and the beginning of secretory release. This fact needs to be established in other animals; Kirkman[1], for example, working with the guinea pig, was able to trace the stages in the degranulation of the basophil cells as well as their development from small chromophobes (as was Severinghaus[2] in the rat), but the mechanism of granule replenishment was not determined.

Apart from these observations, there are no others similarly based on staining reaction sufficient to disprove an alternative interpretation of the functional nature of the granulated chromophil cell. It could be argued that the granules represent merely a surplus prosecretion, so that if synthesis and release proceed at the same rate there will be no change in the degree of granulation, and degranulation will be due to a temporary increase of release over synthesis. Should this be the actual state of affairs it would imply that granulated as well as degranulating cells may be actively releasing hormones and consequently the interpretation of variations in the histological composition of the gland in relation to its activity would become a problem of extremely great complexity. These matters in relation to the activity of certain exocrine glands have been considered in some detail by Hirsch[36].

Further light, however, is thrown on this subject when the relation of the degree of granulation to the state of the Golgi body is considered. If the evidence already cited (and it is only a small part of it) justifies the assumption that increased secretory activity—whether of synthesis, release, or both—is associated with Golgi body hypertrophy, then the Golgi bodies of any cells in an active secretory state, whether granulated or degranulating, should show some degree of hypertrophy. An examination of the records of glands specially impregnated to show the Golgi material definitely gives the impression that there is no hypertrophy in fully granulated cells. This is further emphasized by the fact that it has been shown that the 'typical', that is, fully granulated, acidophils and basophils of the rat have characteristically shaped Golgi bodies readily distinguishable from each other[2].

Similar observations have been made for the cat by Atwell[37]. These differences would probably have been difficult to establish had there been any considerable hypertrophy together with a secretory activity existing in such granulated cells, for such a condition would presumably have tended to reduce the morphological differences between the two Golgi types. It might, of course, be argued that secretory activity in the normal anterior pituitary is not associated with any marked Golgi body hypertrophy, that produced by experimental methods such as the injection of œstrogens being an abnormal state due to over-stimulation. Hagquist[38], however, studying the cytological changes in the anterior pituitary of the female guinea pig during its reproductive cycle, has reported a loss of granules in both types of chromophil cell as occurring about the eighth day of the cycle, accompanied by a marked and progressive hypertrophy of the Golgi material. Such a rhythmic process indicates that hypertrophy during secretory activity is characteristic of the Golgi body and supports the conclusion that the cycle of the chromophil cells is essentially one of alternating granule accumulation and granule loss.

In addition, it may be noted that in glands where there is no reason to believe that activity is markedly rhythmical, such as the pancreatic islets[39] and the parathyroid[8,10], the Golgi body is found to present varied configurations indicative of varying states of activity in the same gland. Therefore from such evidence as has been presented it may reasonably be inferred that in the anterior pituitary, and probably in the thyroid, parathyroid and pancreatic islets, secretory activity is associated with Golgi hypertrophy even under normal conditions. There is, of course, the possibility that in the islet tissue variations in the Golgi body morphology may be associated with the different cell types, but this is a question yet to be investigated.

The relation of the Golgi body changes to the two phases of secretory activity is more difficult to determine, and most of the available data again relate to the anterior pituitary. Theoretically, the best approach to this problem would be to investigate the effect of slowing down or stopping experimentally one or other of the two phases. There is evidence that in the female rat heavy doses of œstrogens inhibit the release of gonadotrophins, since atrophy of the ovaries results[40]; yet the cytological picture is one of great activity—degranulated cells and hypertrophied Golgi bodies[29, 28]. Presumably in this case a state of exhaustion has been produced resulting from a stimulation of secretory release far in excess of synthesis. This at first sight suggests a correlation between the Golgi material and secretory release. There is no proof, however, that the greatly enlarged Golgi bodies may not have been correlated with an initial increase of synthetic activity and afterwards maintained by an even greater secretory release. In other words, it still allows of the possibility that Golgi hypertrophy is associated with both phases of activity.

Gonadectomy in some animals produces changes which some have considered as being in part antithetic to those resulting from œstrogen injections. In the rat, castration results in two distinct changes, the one being an increase in the proportion of basophils, due according to Pomerat[41] to an increase in mitotic activity of the pre-existing basophils, the other the appearance of characteristic vacuolated castration cells. Similar changes have been reported in rats after artificial cryptorchidism[42, 43] and in dogs after the injection of canine antihormone[44]. It has been suggested by Severinghaus[28] that castration vacuolation might be due to a granule solution resulting from an augmentation of secretion production and an inhibition of its release. If this is the case, as seems reasonable, the hypertrophy of the Golgi material during the early phases of vacuolation (for there is a regression later on) suggests that it is associated with secretion production. But, again, there is no proof that castration does not involve an initial transitory increase of secretory release. Finally, in describing the transition from the inactive small chromophobes to the basophils in the guinea pig, Kirkman[1] records that, just prior to the appearance of the granules, the Golgi body hypertrophies and the mitochondria become scattered, and Hagquist[38] for the same animal indicates that there is some hypertrophy during the process of granulation in chromophils, although the maximum is attained during degranulation, where there is also the greatest mitochondrial dispersion. Thus the scanty data available do not permit of any conclusion, but suggest that the Golgi body is involved in both phases of secretory activity. The thyroid gland contributes little to the elucidation of the precise role of the Golgi body, because its study is complicated by the problems of colloid release from the follicles, in which the Golgi material may also participate.

In regard to the function of mitochondria in secretion, an increase in their number is associated, for example, with the degranulating chromophil cells of the anterior pituitary of the rat[28] and guinea pig[1] during pregnancy, and after œstrone administration in the rat[28]. It has also been noted previously that changes in the mitochondrial dispersion in relation to the state of granulation occur in the guinea pig. In the thyroid, Okkels[33], and Bailiff[26] observed a massing of mitochondria in the apical poles of the cells following upon the stimulation of secretion into the follicular lumen. Okkels[33], from his observations, suggested that the mitrochondria acted as condensers of the secretion. Other workers have recorded changes in the mitochrondrial morphology of the thyroid, following upon experimental treatments. Seecof[45], and Cramer and Ludford[25] described a filamentous condition resulting from stimulation induced respectively by partial thyroidectomy and low temperature. The same workers observed a conversion into a granular state consequent upon a reduction in cellular activity. These observations certainly indicate that the mitochondria have a role in secretory activity, but there is insufficient evidence to show its precise nature.

Finally, in the adrenal cortex there are no records of changes in the mitochondria and Golgi material which could be correlated with secretory activity. There is, however, evidence to show that when the activity of the cortex is stimulated experimentally, by exposure of the animal to cold, for example, there follows an initial increase of lipoid material followed by a decrease, as the stimulation is maintained. Flexner and Grollman[16] regarded this initial increase of lipoid as being indicative of increased activity. On the other hand, Dosne and Dalton[15], interpreting similar results, regarded the initial increase as a kind of compensation reaction, further increase in activity being accompanied by lipoid loss. This interpretation is supported by the investigations of Bennett[47], who has produced evidence which indicates that the adrenal cortex of the cat may be conveniently divided into four zones, on the basis of their lipoid content, and on their reaction to a histochemical test designed to show the presence of the keto-groups of the cortical sterones. He found that the reaction was practically confined to that zone of the cortex (consisting of part of the zona fasciculata) which is richest in lipoids—this he called the secretory zone. Since it was found also that removal of the lipoid with suitable solvents resulted in an inability to detect the keto-groups, he concluded that there was probably an intimate relation between the two, so that if stimulation of the cortex brings about a rapid release of the cortical hormone, the progressive disappearance of the lipoid droplets is thus to be expected.

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AGRICULTURAL RESEARCH INSTITUTES AND THE FUTURE

By Dr. B. A. KEEN, F.R.S.

THE organization and administration of agricultural research, in common with many other national activities, will receive critical—and, it may be hoped—constructive attention as a result of the War. Although the post-war structure of our agriculture cannot yet be predicted with confidence, considerable changes will probably occur, which should be accompanied—and so far as possible, anticipated—by appropriate new perspectives in the agricultural research, advisory and teaching organizations.

This article deals primarily with research and is further restricted to arable agriculture. Although other branches, such as animal husbandry and economics, also have their own vital problems, it is not likely that their framework of organization and administration will need to be vastly different from that proper to research in arable agriculture. Indeed, there are so many problems requiring joint examination that some organization to serve those needs that are common to all branches is not only desirable, but also essential.

If one looks back at, say, the last hundred years of research in arable agriculture, a clear pattern can be seen, especially in Great Britain. There have been two well-defined stages, the second of which is already changing into a third. The picture is one of orderly and progressive development, and the third stage is a logical outcome of the second.

It so happens that the history of Rothamsted well illustrates the sequence. The first stage—the era of Lawes and Gilbert—was a frontal attack on a problem of practical agriculture: the manuring of crops. The method was one of simple and direct field experiments; the function of the laboratories was to produce a mass of expository analytical data on the soils and crops. It is true that valuable novelties were employed in the method of approach: the problem was detached from its context of crop rotations and agricultural systems by growing each crop continuously. The method well served its purpose, for it was quick, and it not only gave striking new information on crop nutrition but the field results were capable of immediate application to practice. The effects of artificial manures on crop yields were so large that they were not wholly obscured even by widely different soils, climates, and agricultural systems. Lawes and Gilbert took little or no direct part in the repetition of their experiments in other areas. Examination of the increasing mass of the Rothamsted data occupied the greater part of their attention; for very many years Gilbert was absorbed in the nitrogen balance sheet for the various plots and in the amounts of nitrogen that could not be accounted for when the analyses of soil, manure, crop, rain and drainage were put together. Had the study of soil microbiology been as well forward then as agricultural chemistry some of the puzzles would have been clearer. However, the important point was that the conclusions and their technical corollaries might have only a local validity; but the full realization of this was to come only later. The effort, in fact, was somewhat like an attempt to make a synoptic chart for our variable continental-seaboard weather from very detailed meteorological observations taken at a single station.

With the deaths of Lawes and Gilbert the first stage of agricultural research closed. The Rothamsted work had shown that agricultural science had extended beyond the scope of any one man. The need for the help of a microbiologist in a problem that began in chemistry has already been mentioned; and, while biochemistry could advance the frontier of agricultural chemistry, it was, in turn, handicapped by lack of knowledge of the physical environment in the soil. Clearly, the help of research workers in many branches of science was needed if soil and plant relationships were to be further elucidated. This second stage of agricultural research began with modest resources, but the Development Commission, and especially the War of 1914–18, gave it a great impetus. It has now been running for some twenty years in substantially the form planned by its designer, the late Sir Daniel Hall. Weaknesses and merits have had time to show themselves, so a review of the organization is appropriate, the more so in view of the many war and post-war agricultural problems.

In this article it is unnecessary to set out the achievements of the second phase of agricultural research. To any unbiased observer they must amply justify the faith of Hall's vision, for the boundaries of agricultural science have been greatly enlarged. To take only one section, a comparison of the original 1912 edition of Russell's "Soil Conditions and Plant Growth" with the seventh, of 1937, shows in striking fashion how far we have travelled in twenty-five years and how much British agricultural scientists have contributed to that progress. The annual reports and papers published by other research institutes—those dealing with market gardening and fruit growing, for example—show equally striking advances in their own spheres of work.

It is important to study the organization under which this work was done. There were some obvious difficulties to overcome: specialists tend to work in water-tight compartments, and few of the new men were likely to have any agricultural background. Thus there was the double problem of fostering team-work so that the new agricultural science should be a coherent whole, and of providing a suitable environment to ensure that technical applications of the scientific advances would not be missed or ignored by the research workers.

Superficially, one single large research institute for the whole of agricultural science would have seemed the solution, but for two inescapable facts: first, agricultural research embraces such widely different activities as animal nutrition, farm economics, plant genetics, and soil physics; and second, effective central direction of research, whether by a director or a committee, is impossible if the number of workers exceeds a certain limited figure. The alternative adopted was a number of smaller institutes, each of which took an agreed broad section of agricultural research as its main concern. A possible looseness of contact between these sections was less important than the reasonable certainty that within each section team-work would build up a coherent picture. Another far-seeing provision was to give each institute the widest freedom of control over its own research programme, for the reason that decentralized control works best. In the past twenty-five years many members of the institutes have studied the organization of agricultural research in other countries, and many overseas visitors have examined our scheme; the almost universal opinion is that none is better than ours and most are less effective.

Nevertheless, no one, least of all those in the research institutes, would claim that the present organization should be continued unchanged merely because it has been successful in the past. Should they be consulted about their own future—and it is to be hoped that they yet will be—it would assuredly be found that those concerned with arable agriculture are anxious that the third stage of agricultural research should be organized, for its pattern and requirements are already quite clear.

The very advances of the second stage showed that many technical conclusions obtained for one soil, climate and agricultural condition were either invalid, or needed modification, elsewhere. To meet this difficulty some of the institutes had built up chains of experiments as best they could. The problems investigated were necessarily restricted, as only the simplest field procedure could be used. Their scope was further limited because the problems had to be those of immediate interest to official or private organizations able to meet some of the costs and to help in securing sites. Although the experiments were simple, incomplete, and beset by various difficulties, they were amply justified by their results both in agricultural science and practice. The overriding needs of war-time agriculture have removed, for the time at least, some of the difficulties: contacts with other institutes and advisory officers are increasing, and an informal network of co-operative field experiments (and demonstrations) is developing. For the first time there emerges a possibility of joint work on some important agricultural problems not included within the interests of official and private organizations.

The freedom of development that characterized the second stage of agricultural research has not only produced the third stage as a logical outcome: it has also provided the technical machinery that makes the next stage possible. The statistical design of experiments to secure comparable results of an ascertainable degree of accuracy enables the maximum of information to be obtained from a given amount of experimental effort, by combining several related questions in one design. Thus, problems concerning two or more research institutes could be dealt with in the same experiment. Such a scheme of field experiments would need co-operative control by the interests concerned through a committee which might work under the ægis of the Agricultural Research Council. The committee would be responsible for selecting the programme from the various proposals put forward and for combining the selected problems in the most economical manner. Each experimental site would be typical of an important soil and farming system.

It is certain that a system of well-distributed replicated experiments will be of the utmost value to the research institutes. It is equally certain that it will enable rapid answers to be given to many urgent post-war agricultural problems of a practical and economic nature, for, as already stated, it is growing up even now under the compelling pressure of immediate war-time problems.

Wars and their aftermaths are conducive to centralized control of many activities. The majority of research workers regard such controls as temporary necessities which have an unfortunate tendency to persist after the need for them has vanished. Lest it should be thought that the scheme outlined above is merely another fashionable war-time centralization, it is desirable to stress the following points: the need for it was apparent before the War; it is a natural development from a second to a third stage of agricultural research. Finally, it does not call for any significant changes in the control and administration of the research institutes. Their record during the twenty-five years of the second stage of agricultural research, and the fundamental work now in hand and projected, are enough to show that they are still efficient instruments in the furtherance of agricultural science.

As stated at the outset, this article deals only with the organization and administration of research in arable agriculture. Contacts with colleagues in various other branches lead me to believe that among agricultural research workers there is general agreement on the situation briefly discussed here and on the best method of dealing with it. But agricultural science ranges so widely that workers in other branches will have their own proposals to offer for the general plan of research organization. One purpose of this article is to promote discussion in these columns and elsewhere, in the belief that a common ground of agreement will emerge; there is no doubt that, especially at the present time, such discussions and expressions of opinion will be very opportune.

OBITUARIES

Dr. Arnold Berliner

The death occurred, on March 23, of Dr. Arnold Berliner, well known to the scientific world as the founder and editor of *Die Naturwissenschaften*.

Berliner belonged to the first generation of 'technical physicists' and worked in close connexion with Emil Rathenau as head of the physics laboratories of the A.E.G. during the period of rapid expansion of this firm. The development of the incandescent carbon lamp and of X-ray bulbs owes much to him—he introduced the first 'getter', phosphorus, in the manufacture of lamps, and the large scars on his arms bore testimony of the early stages of experimenting with X-rays when their dangers were not yet realized. Among other technical problems advanced by Berliner was that of the phonograph: he was the first to introduce the disk form for records (1889).

As an author Berliner was successful with a textbook on physics which appeared in several editions. It is conspicuous for stressing the application of physical knowledge to technical problems, many years in advance of a recognized 'technical physics'. In "Physikalisches Handwörterbuch", edited by Berliner and Scheel, many of the articles defining concepts or describing methods used in physics are from Berliner's pen.

These and other literary products, sound as they are, have not attained the importance of Berliner's creation of *Die Naturwissenschaften* in 1912. Framed on the model of NATURE, for the achievements of which Berliner had the greatest admiration, this journal for general science was to draw closer together the physical and the biological, the experimental and the descriptive sciences. Berliner addressed himself mainly to the then young generation of men of science. Much of the success of the journal was due to Berliner's vivid personality, his close contact with the majority of young physicists and mathematicians and his initiative in formulating the subject of articles he wanted written for his journal. Thus *Die Naturwissenschaften* became a mirror reflecting the development of science during 1913–30. To what extent the success of the journal depended on its editor became apparent when his work became limited by a serious eye trouble which made reading nearly impossible to him for many years. His field of vision was filled with a misty haze; after having vainly consulted many oculists, Berliner found the physicists' solution of eliminating much of the light diffusely scattered in his eye by filtering away the short-wave part of the spectrum and reading by red light only.

Berliner's desire was to complete the twenty-fifth volume of *Die Naturwissenschaften*, his very own creation. In the "Aryanization" of the publishing firm of Julius Springer, the old man was turned out of his office in 1935. He had since lived a life of reminiscence of his many friends—artists, men of science and politicians. Various attempts to find a new home outside Germany were unsuccessful. Now his friends deplore in his tragic escape from life the loss of one who represented much of the best cultural traditions of a bygone Germany, and of a warm-hearted and helpful friend. P. P. EWALD.

DURING the years following the War of 1914–18, Arnold Berliner was a prominent figure in German science. There was no Naturforscher-Versammlung and no meeting of the Physikalische Gesellschaft where his small but powerful figure with the characteristic beard and big spectacles did not appear, no scientific conference where his wise counsel was not welcomed. He never claimed to be a man of science, but only a "poor technician". But he insisted that every article in *Die Naturwissenschaften* should be written in such a way that his "simple mind" could understand it. How few of the contributions proved up to the high standard which he set, and how lively was the ensuing correspondence! He had a collection of the most remarkable extracts from these letters, as material on the "psychology of the scientist", whom he liked to describe as "mimosenhaftes Stachelschwein" (a hybrid of mimosa and porcupine). Perhaps he did not realize how well this description fitted his own character, which was the strangest mixture of infinite kindness, generosity, greatness of outlook and personal touchiness.

He was a technician by profession, an amateur scientist; but his real life was in literature, art and music. He read abundantly and remembered everything. He knew all the great galleries of Italy and Germany, and filled his home with good modern pictures. But his greatest pleasure were his annual visits to the Bach, Beethoven, Brahms festivals and to Bayreuth. Of his numerous friendships with men of importance he valued none higher than that with Gustav Mahler, the composer. Music was left to him when the decay of his eye-sight deprived him of reading and enjoying art. Finally, even music was taken from him, for going to concerts became impossible for a Jew. The work of his life was broken and his last years were lonely, dark and tragic. Many of his friends were dispersed over the globe. But he will not be forgotten by them. MAX BORN.

Prof. A. L. Selby

ARTHUR LAIDLAW SELBY, born on July 2, 1861, at Atherton, Lancashire, was the eldest son of Atherton Thomas Selby. He was educated at Heversham Grammar School and at Queen's College, Oxford. He was a fellow of Merton College from 1886 until 1893, and examiner in the Honour School of Natural Science in 1889–90 and 1900–1. He married Dorothy, daughter of Ernest Beck of Great Amwell.

After holding an assistant demonstratorship in physics at the Clarendon Laboratory, Oxford, for six years, Selby was in 1890 appointed assistant professor of physics at Cardiff University College, becoming professor of physics in 1897. He occupied this chair for twenty-nine years, retiring in 1926 with the title of professor emeritus. During his sixteen years of retirement he continued to reside in Cardiff, and maintained the closest possible touch with the College. He died on July 22 last, at the age of eighty-one. He is survived by his widow.

It would be vain to attempt in a short obituary notice to do justice to the manifold services rendered by Selby to the University College at Cardiff, to higher education in Wales, and to the many students who have passed through his department. His personality, his clear and unbiased judgment, and his inimitable command of phrase, marked him as a leader in committee and as an inspiring lecturer in the class-room. His transparent honesty of purpose and his sympathetic understanding rapidly gained for him the confidence of his students and colleagues, and he never failed to win the lasting affection of those who worked with him.

His name will be perpetuated in the series of Selby Lectures, and will be held in affectionate remembrance by all who knew him. R. T. DUNBAR.

NEWS and VIEWS

Anglo-Soviet Scientific Collaboration Committee

IT is now four months since the formation of the Anglo-Soviet Scientific Collaboration Committee under the chairmanship of Sir John Russell. The Committee came into being as a result of a conference held last March at the Royal Society to discuss the development of contacts between British and Russian scientific workers. With Sir John Russell as chairman and Mr. J. G. Crowther as vice-chairman, the Committee arranged that scientific communications should be forwarded to the U.S.S.R. according to the following procedure. Letters addressed by individual British men of science to individual Russian men of science, or communications from British scientific and technical societies to the corresponding Russian societies, can be sent either to Sir John Russell, Ministry of Information, Malet Street, London, W.C.1, or to Mr. J. G. Crowther, British Council, 3 Hanover Street, London, W.1, who will take the necessary steps to forward the communications to the U.S.S.R. This amplified the machinery for exchange of scientific information with the U.S.S.R. already set up by the British Council.

A number of communications have already been forwarded to the U.S.S.R. in this way, but owing to the time taken in transit and the inevitable dispersion of Soviet scientific workers, and the evacuation of scientific institutions in the Soviet Union, it is realized that it may be some time before replies reach Great Britain. In collaboration with the University of London School of Slavonic Studies, the Committee has arranged for special Russian classes for scientific workers. In this way, many young scientists are being encouraged for a moderate fee to learn the Russian language. The Committee has fully realized the importance of a satisfactory exchange of scientific literature between Great Britain and the U.S.S.R., and as a basis for this has recommended that a survey shall be undertaken of the war holdings of Russian scientific and technical periodicals in Great Britain, with details of location and accessibility. The British Council has agreed to finance the survey, which will be organized by ASLIB. The survey is already under way, and it is hoped that it will be completed in two months time. Librarians of scientific institutions are now asked to co-operate in this important piece of work by completing and returning their questionnaires as soon as possible. When the survey is completed the Committee will endeavour to obtain from the U.S.S.R. the periodicals still being published in the Soviet Union, but which no longer reach Great Britain.

In view of the urgent demand for a Russian-English technical dictionary, the Committee is making a collection of existing glossaries of Russian technical and scientific terms in Great Britain and the United States, with the idea of placing a complete set in the Science Library in London, where they can be consulted. If at a later stage it should be found possible to compile a new Russian-English technical dictionary, these glossaries will form a valuable basis to work on. A location list of Russian technical dictionaries is also being compiled, and scientific workers are asked to assist in this by sending to the Secretary of the Committee a list of dictionaries in their possession. Several scientific societies and individual men of science have approached the Committee concerning the provision of a panel of Russian scientific translators. The Committee has already collected together the names of several qualified Russian translators, and is prepared to receive names of reliable translators for inclusion in the list.

What Constitutes a Nation ?

WHAT constitutes a nationality is as hard a question to answer as the allied one of what is denoted by the word race. J. R. Swanton, in *Smithsonian Institution War Background Studies*, No. 2, has presented the problem clearly in a manner the non-expert can readily grasp. Obviously many factors go to the formation of a nation: common physical type, geographical background, governmental unity, language, religion, economics, etc. But when the major cultures of the world, both past and present, are considered it will be found that no one of these is a dominant factor. There are true nations where the physical types are hopelessly mixed, as well as other factors which one would have thought vital to unity. On the other hand, even one of the more important criteria, namely, language, can fail to be a binding element—as witness England and the United States. Here, though the language is the same, no one can deny that there are two distinct nations. On the whole, the author seems to be driven back to the idea of the importance of voluntary associations of folk living under a government desired by the majority. This is, of course, difficult to test in the case of past civilizations, but seems to be applicable to modern nations. But if so it cannot be too much stressed, indeed it is the keystone of the theory, that what one nation may desire, in fact what may be the cement that makes it a nation, may not be at all what appeals to other agglomerations of men and women whose nationality will be determined by a totally different outlook on life.

Industrial Health Research Board

THE Medical Research Council has appointed the following to be the members of its Industrial Health Research Board during the period 1942–45: The Rt. Hon. the Earl De La Warr (*chairman*), Prof. F. C. Bartlett, Brig.-Gen. A. C. Baylay, Dr. J. C. Bridge, Dr. A. N. Drury, Dr. T. Ferguson, Dr. M. W. Goldblatt, Dr. A. Bradford Hill, Dr. Donald Hunter, Prof. Esther Killick, Air Vice-Marshal Sir David Munro and Mr. J. L. Smyth. Prof. A. W. M. Ellis, director of research in industrial medicine under the Council, will also attend all meetings. Dr. R. S. F. Schilling, one of H.M. medical inspectors of factories, has been seconded to the service of the Council by the Ministry of Labour to act as Secretary of the Board. The terms of reference of the Board have recently been revised and are now as follows: "To advise and assist the Medical Research Council in promoting scientific investigations into problems of health among workers, including occupational and environmental factors in the causation of ill-health and disease, and the relation of methods and conditions of work to the functions and efficiency of body and mind; and in making known such results of these researches as are capable of useful application to practical needs."

Jean-Baptiste Van Mons (1765—1842)

ON September 6 occurs the centenary of the death of the once famous Belgian chemist and horticulturist Jean-Baptiste Van Mons who died at Louvain in 1842 at the age of seventy-six after a life entirely devoted to science. Born in Brussels on November 11, 1765, when Belgium was under foreign domination, he lived to see Austrian rule give way to French and French to Dutch, and then in 1830 to see his country gain her independence. But under every regime Van Mons steadily continued his work and it was largely through his labours that discoveries made in France became known in the countries with which she was so frequently at war. By profession Van Mons was a pharmacist, but when twenty years of age he wrote an essay on the new principles of chemistry and he subsequently corresponded with Lavoisier, Fourcroy, Monge Hachette and others. By the French authorities he was entrusted with a survey of the Belgian mines and in 1797 was made a professor at the central school of the department of Dyle. On the invitation of the French chemists he assisted in editing the *Annales de chimie* and in 1801 founded the *Journal de chimie et de physique*. By his own contributions to these and to the periodicals of Gren, Crelle, Brugnatelli, Nicholson and others he spread abroad a knowledge of the work of such as Volta, Vauquelin, Fourcroy and Chenevix. He was the first to introduce vaccination into Belgium, and all his life he experimented on the improvement of fruit trees. When the Belgian Academy was revived in 1816 Van Mons was nominated to a seat and the following year he was made professor of chemistry and agriculture in the restored University of Louvain. This post he held until 1836. Of his sons, Louis-Ferdinand Van Mons (1796–1847) was one of the chief artillery officers of Belgium and Charles-Jacques Van Mons (1798–1837) was professor of pathology in the University of Brussels.

Francis Adams (1796-1861)

UNDER the title of "A Great Country Doctor", the June issue of the *Bulletin of the History of Medicine* contains a lively article by Prof. Charles Singer on Francis Adams of Banchory, the son of a village labourer who rose to be one of the greatest medical scholars of his age. His principal achievements were a translation of "The Genuine Works of Hippocrates" (1849), which Prof. Singer describes as "probably the most widely read of any work on medical history in the language"; "The Seven Books of Paulus Aegineta" (1844–47), which "retains to this day its position as far and away the finest venture in pure historical medical research in the English language"; and "The Extant Works of Aretæus the Cappadocian" (1853), which unlike the other two works contains the Greek text as well as the translation. His minor publications include articles to medical journals, translations of Horace and Musaeus into English verse, of Gray's "Elegy" into Latin, and of Wolfe's poem on Sir John Moore into Greek. He also collaborated with his son, Dr. Leith Adams, F.R.S., in a paper read before the British Association at Aberdeen in 1859 entitled "On Ornithology as a Branch of a

Liberal Education", and contributed to Dunbar and Barker's "Greek and English Lexicon" (1831), Lemprière's "Classical Dictionary" (1838), and Greenhill's "Theophilus" (1842). Adams was not only a great scholar but was also an excellent doctor. "His first love and his last", says Prof. Singer, was his practice, his patients and the poor." His devotion to his profession was best shown by his declining the chair of Greek at the University of Aberdeen, which afterwards gave him an honorary doctorate. He paid several visits to Oxford and London, where he made friends with many learned men, particularly James Quain and William Sharpey, the founders of the modern academic teaching of anatomy and physiology in England. Dr. Singer ends his fine essay by saying that though the ranks of general practitioners in Britain have produced many eminent men of science, such as J. A. Lockhart, Sir James Mackenzie and J. A. MacMunn, none of equal distinction as a scholar practised in so isolated a locality as Adams.

A Pilot-Channel Regulator for the 'K-1' Carrier System

VARIATIONS in attenuation of the cable conductors used for the K–1 carrier system are compensated by corresponding changes of gain under control of a pilot-wire regulating system. Since these changes in attenuation are due primarily to temperature changes, and since all pairs in the same cable are approximately at the same temperature, a pilot regulation system—in which the gain over the various pairs is adjusted to conform to the temperature of one pair of wires in the cable—is a simple and satisfactory way of handling the regulation. There are, however, certain minor deviations from pair to pair for which such a system will not provide, and with long circuits over, say, some five hundred miles, some additional regulation will be needed to take care of these residual deviations.

An article by J. H. Bollman (*Bell Lab. Rec.*, **20**, No. 10; June, 1942) describes a regulator using thermistors as controlling elements, supplementing the normal regulating system. The new regulator operates on pilot channels rather than on a pilot-wire. Currents of single-frequency are transmitted over a pair of conductors, the gain being regulated in accordance with the attenuation changes of these pilot channels. Regulation is thus directly associated with the carrier system operating on that pair. The change in gain is the same at all frequencies. Regulation as designed is used not only to compensate for the residual regulation errors of a 300–500 mile circuit, but also to take care of the flat regulation of the previous repeater section (12–20 miles) and also the slope and bulge regulation of the previous twist section (50–300 miles), obviating the necessity for pilot-wire and twist regulators. Measurements over a four-monthly period, using continuous recorders, showed that variations in the net losses of the twelve channels due to changes in line loss were not more than 0·5 db., an improvement of more than two to one as compared to the performance previously available without the deviation regulator.

Overheating of Electric Motors

AN article on this subject in the *Electrical Review* of July 31 opens with a brief survey of overheating due to dirt or other foreign matter obstructing the ventilating pipes, ducts and passages of motors. Mention is made of the lagging effect which waste materials may have on the motor casing, and useful suggestions are given for the improvement and maintenance of ventilation. Since the rate of heat generation is proportional to the square of the load, protection against overloading is advised. It is suggested that motors be protected by a tripping device operating at 25 per cent sustained overload, or thermostatically controlled if subjected to large rapid load fluctuations. The liability of cotton insulation to char at about 100° C. is mentioned in stressing the safe temperature rise of a winding as being about 72° C. above that of the surrounding atmosphere.

The author then outlines the effects of accidentally sustained starting currents, mentioning in this connexion the mal-operation of star-delta starters. Warnings are given against running D.C. variable-speed motors at abnormal speeds; series connecting the windings of small A.C. motors intended for use on two voltages when on full load; prolonged connexions of the starting windings of split-phase single-phase motors; and the running of polyphase motors with one phase of the supply open-circuited. The remainder of the article is devoted to interesting points in maintenance, attention being directed to worn bearings, lubrication, short-circuited windings, short-circuiting of commutators by carbon dust, and the careless handling of dismantled machines as possible causes of overheating. Attention to the many points referred to will doubtless minimize the risk of overheating, rapid deterioration and breakdown of the plant.

Rats and the War

ACCORDING to the *Medical Officer* of August 15, Dr. Charles White, medical officer of health for the City of London, has recently issued a report to the effect that while the devastation caused by enemy action has undoubtedly reduced the rat population, particularly in the Cripplegate area, in other districts there is still severe infestation by these vermin. Premises previously more or less free now suffer constant infestation, especially buildings in which the upper floors only were damaged by fire or blast. The hundreds of sandbag blast walls have formed a safe harbour for rats, but many have now been replaced by brick structures. Infestation by rats has been aggravated by the introduction of fire-guarding and consequent indiscriminate feeding, as well as by leaving doors open throughout the buildings to facilitate fire-guards access to rooms. Dr. White recommends that when structural reconstruction is considered adequate steps should be taken to construct rat-free buildings.

The National Trust

IT is satisfactory to learn from the forty-seventh annual report of the National Trust for Places of Historic Interest or Natural Beauty that progress is being made in spite of the War. The recent outstanding addition to the Trust's properties is the Wallington estate in Northumberland, but while this is the largest (13,000 acres) there are many other interesting and beautiful places now saved for the nation in no less than twelve counties. The report, which is also concerned with problems of future upkeep, preservations of buildings and amenities, and of the plant, fish and even bird life of Ullswater, can be obtained at 7 Buckingham Palace Gardens, Westminster, and is a cheering document to turn to in this time of strife and destruction.

Post-war Medical Relief

In a timely pamphlet (Post-War Problems Medical Relief in Europe. The Royal Institute of International Affairs, 1942. Pp. 67. 2*s*. net.), Dr. M. D. Mackenzie emphasizes the importance of organizing before the end of the War a central co-ordinating administrative machine composed at first of delegates of the allied countries and later of representatives of occupied countries as well. He suggests that the Health Organisation of the League of Nations, which still functions, should be used and should be joined by international voluntary organizations (International Red Cross, Society of Friends, etc.), British and American voluntary organizations for relief in Europe and the national voluntary organization in each of the countries to which relief is being given. In addition to food and clothing, medical relief material of all kinds will be wanted, including vaccine against smallpox and enteric fever, disinfectants, quinine and other important drugs, as well as re-establishment of the milk supply. The specific diseases which will need attention are malnutrition including tuberculosis, typhus fever, malaria and other infectious diseases as well as cardiac and digestive disorders.

Smallpox in the United States

According to an annotation in the June issue of the *Statistical Bulletin*, the organ of the Metropolitan Life Assurance Company of New York, a remarkably low record for smallpox was established for 1941 in the United States, only 1,432 cases having been reported in the whole country during that year, or scarcely more than half the number notified in 1940 (2,795). In Canada also the incidence of smallpox was very low, only 26 cases having been reported, all but one of which occurred in the single province of Saskatchewan. As in previous years, the type of the disease in the United States was mild, and it is probable that not more than ten deaths occurred. There is good reason to believe that the present decline is real, and that the disease will be eradicated in the next decade. During the past twenty-one years, nearly half a million cases of smallpox have been reported in the United States, one State alone, Indiana, being represented by 37,902 cases. The chief centre of smallpox infection in the United States recently has been in the north-west corner of the country which comprises the States of Montana, Washington, Idaho and Oregon, while the lowest incidence is in the New England and Middle Atlantic States, followed by the States in the south-east corner of the country. The high incidence in Indiana is to be attributed to the fact that at a recent survey less than 13 per cent of the Indiana pre-school children and not more than 53 per cent of school children less than ten years of age were found to be vaccinated. It is therefore highly desirable that the following warnings should be widely spread: (1) no one is naturally immune to smallpox; (2) protection against it must be acquired artificially by vaccination; (3) the immunity conferred by vaccination is not life long, but must be renewed by revaccination at intervals of seven years or when an outbreak of smallpox occurs.

Recent Earthquakes

On August 24 an earthquake of considerable intensity caused destruction in places 50 miles apart in southern Peru. The epicentre of the shock was probably a little distance to the north-west of Acari, which is a town in the foothills of the Andes in the province of Arequipa. The town of Acari was almost destroyed and there are reported to be large numbers of dead and injured. At Nazca, a town some 50 miles north-west of Acari, one third of the buildings were completely destroyed and 80 per cent of the population are homeless. Here 20 people are reported to have been killed and several injured. At the coast near the port of Nazca the sea receded some 200 yards and then came back and flooded the port together with about 1,000 yd. of the Pan-American coastal highway. The shock was well recorded at Stonyhurst College Observatory, near Blackburn; the Rev. J. P. Rowland, *S.J.*, reads eP_E at 23h. 03m. 37s. U.T. on August 24, the maximum ground amplitude at Stonyhurst being 600 μ at 39m. 40s. U.T. The shock finished recording at 04h. 10m. U.T. on August 25, all the interpretations being tentative.

The seismograph at Stonyhurst also recorded another earthquake, this time on August 27 at 06h. 18m. 40s. U.T. The record was well defined, but the amplitudes were much smaller than those of the Peruvian shock, and the epicentral distance from Stonyhurst much less. The German radio has reported an earthquake in Albania. In one village 80 per cent of the buildings are said to be uninhabitable, and many people killed and injured.

Announcements

Sir John Orr, director of the Rowett Research Institute, Aberdeen, has been appointed professor of agriculture in the University of Aberdeen. He will retain the directorship of the Institute.

The Minister of Agriculture and Fisheries has appointed Mr. F. A. Secrett to be honorary adviser on vegetable production. Mr. Secrett is the head of Messrs. F. A. Secrett and Co., the well-known firm of vegetable growers. His wide experience and intimate knowledge of the industry will be invaluable to the Ministry in the work of increasing the production of home-grown vegetables.

The next meeting of the Parliamentary and Scientific Committee to be held in Room 6 of the House of Commons, at 2.45 p.m. on September 8, will consider, among other things: "further action to be taken on the Motion now on the Order Papers of the House with a view to the setting up of a central Technical and Scientific Board; to consider representations from a representative from the Geological Society with regard to the better use of geology in connexion with the war effort."

Following the conference held at the Institution of Civil Engineers on August 25 to discuss generally the question of civil engineering and the building industry, discussion meetings will be held at four-weekly intervals beginning September 15 at 2.30 p.m., to consider the specific problems that emerge. Mr. George Hicks, Parliamentary Secretary to the Ministry of Works and Planning, will be the principal speaker at the first meeting. Particulars and tickets for a particular meeting or for the series may be obtained on application to the secretary of the Institution of Civil Engineers, Great George Street, Westminster.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Antipressor and Depressor Effects of Oxidation Products of Pressor Amines

PRESSOR amines comprise a great variety of β-substituted primary and secondary alkylamines the cyclic portion of which may contain one or two phenol groups. The various functional groups determine the catabolic fate of these amines which, in turn, contribute to the nature, intensity and duration of their action. Because of the role attributed to pressor amines in essential[1] and in experimental[2] hypertension, the mechanism of their inactivation and destruction is of pathological and pharmacological interest.

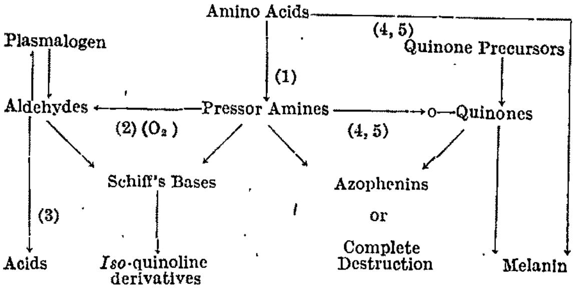
(*a*) Oxidative mechanisms can attack either the side chain or the cyclic portion of the pressor amine molecule. Oxidation of the latter leads from, or through, catechol derivatives to *ortho*-quinones and eventually to melanins. The formation of *o*-diphenolic compounds by enzymatic or other chemical and by physical means in the animal body from monophenols is still obscure[3,4]. The *ortho*-quinones, known as intermediaries in melanin formation[5], may also undergo azophenine-like condensations with additional amine molecules. Thus, the destruction and physiological inactivation of additional molecules of pressor amines is accomplished.

Schroeder and Adams[6] lowered the blood pressure in experimental hypertension by injection of mushroom tyrosinase. This effect is attributable either to complete enzymatic oxidation of the phenolic pressor amines or to their inactivation by the *ortho*-quinoid intermediaries formed in the course of tyrosinase action. The latter alternative is supported by the lowering of blood pressure in experimentally hypertensive rats and dogs after injections of the quinone precursor dihydroxyphenylalanine together with small amounts of copper salts as oxidation catalyst[7]; analogous *in vitro* experiments demonstrate that pressor amines (tested in crucial experiments on cats) are destroyed by aeration with quinone precursors and also with aliphatic enediols in the presence of heavy metal catalysts[7]. Adrenochrom, a cyclized *ortho*-quinone derived from adrenaline, is also known as a hydrogen acceptor in vital oxidation processes[8] and its 'trigger action' upon certain effects of adrenaline illustrates the physiological operation of a catechol-*ortho*-quinone system. Preliminary experiments[9] with injection of relatively stable halogenated adrenochrom derivatives show an antipressor effect in experimentally hypertensive rats and dogs.

(*b*) Kisch[10] has shown that the aeration of solutions of amino acids and dipeptides in the presence of adrenaline and other quinone precursors such as hydroxyquinol results in oxidative deamination. Beyer[11] obtained analogous results with ascorbic acid, an aliphatic diketone precursor. Thus, in Kisch's experimental model an intermediary product of nuclear oxidation catalyses in its turn a side chain oxidation.

(*c*) Enzymatic oxidation of the side chain of pressor amines is accomplished by amine oxidase found in kidney, liver, brain and other organs. This enzyme was discovered by Hare[12] who demonstrated its effects on tyramine *in vitro*. The products of oxidative deamination are ammonia and the corresponding aldehydes, in the case of tyramine, *p*-hydroxyphenylacetaldehyde. The aldehydes formed by the action of this enzyme are subject to further oxidation by the hepatic xanthine oxidase to the corresponding acids, which have so far not been found to be of physiological significance. This, however, is not the only reaction which these aldehydes may undergo. Mrs. M. Hare Bernheim[13] discussed the potential condensation of one molecule aldehyde with another molecule of unchanged amine to a Schiff's base. Again, as in the case of the *ortho*-quinoid primary destruction products, the formation of the aldehydes does not mean only the removal of one molecule of pressor amine, but produces an additional antipressor effect by condensation of the aldehyde with a second molecule of amine to a physiologically inert compound. These Schiff's bases are, in turn, subject to cyclization yielding *iso*-quinoline derivatives along the line of the papaverine synthesis of Robinson[14]. These *iso*-quinoline derivatives are related to the fast-acting alkaloids of the papaverine and laudanosine group. Their formation could explain the depressor effect of homoprotocatechuic aldehyde, the deamination product of hydroxytryamine, observed by Holtz[15]. A similar chemical transformation of adrenaline into a substance of antagonistic properties may account for the so-called diphasic action of adrenaline injections[16]. Especially the infusion of minute amounts accentuates this antagonistic action as the rate of transformation exceeds the rate of direct action.

The subjoined diagram shows that the various possible oxidation products of pressor amines may have: (1) an antipressor effect by inactivating additional amounts of pressor amine; (2) a depressor effect as in the case of *iso*-quinoline derivatives and perhaps their aldehydic parent substances; (3) the final oxidation products such as melanin and aromatic acids are indifferent, and there is finally (4) the possibility of storing a physiologically active intermediary in a temporarily inert state.



(1) Decarboxylase (aerobic and anaerobic).
(2) Amine oxidase (aerobic), also with creso-indophenol as H-acceptor[22].
(3) Xanthin oxidase.
(4) Monophenolase and (5) catecholase.

Aldehydes are known as rather reactive substances unlikely to persist in living tissue. Certain aliphatic aldehydes, however, have been found by Feulgen[17] in lipoid extracts of muscle, blood and viscera bound by cyclic acetal linkages in the so-called plasmalogen. This acetal phosphatid upon hydrolysis liberates plasmal, a mixture of aldehydes, including stearic and palmitic aldehyde. The presence of aldehydes other than these saturated higher aldehydes has been suspected by Feulgen[18]. Attempts in collaboration with H. Sobotka to isolate aldehydes from hog kidney have resulted in the identification of stearic aldehyde[19], but also indicate the presence of mixed aromatic-aliphatic aldehydes. An interchange may exist between these two classes of aldehydes and they may replace each other in acetal phosphatides. Striking differences in the occurrence and distribution of bound aldehyde in normal and pathological kidneys from human autopsies speak for the physiological significance of stored aldehyde[19]. Thus, aldehydes with antipressor and depressor effect may be conserved in this form, so that they may be mobilized for various needs of the organism. These aldehyde depots can be depleted in tissue sections by incubation with aromatic amines such as sulphanilic and *para*-aminobenzoic acids and may serve a similar purpose of local detoxification *in vivo*. They would be especially suitable to combat undesirable accumulations of pressor amines. Thus they may function as temporary 'buffers' delaying the onset of experimental hypertension which, in spite of the immediate production of renal ischemia, appears only three or four days after the Goldblatt operation.

The above diagram illustrates the hypothetical sequences of reactions from cyclic amino acids through pressor amines, antipressor and depressor substances to inert end-products. The equilibrium between these transformations, obtaining under physiological conditions, is disturbed in renal hypertension; the pressor amines then accumulate and at the same time their antagonists are depleted and used up. Extracts with depressor effect have been obtained from normal kidney[20]. In experimental unilateral renal ischemia in dogs[21] the production of the antagonists in the intact kidney prevents the persistence of hypertension in spite of the continuous output of pressor amines from the ischemic kidney.

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New York. July 10.

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*George Blumenthal, Jr. Fellow. Partly supported by a grant of Messrs. Winthrop Chemical Company.

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Self-incompatibility in Certain Diploid Potato Species

PAL and Puskar Nath[1] have reported that the diploid ($2n = 24$) potato species, *S. arrac-papa*, *S. Caldasii*, *S. chacoense*, *S. Jamesii* and *S. subtilius*, are self-incompatible. Under Cambridge conditions the diploid species, *S. Rybinii*, *S. boyacense*, *S. lanciforme* and *S. phureja*, also appear to be self-incompatible.

Only one clone of *S. Rybinii*, which Salaman[2] states he was unable to infect with either leaf roll or potato virus *Y*, has been brought to Europe, and on selfing this clone never sets berries. It will, however, cross readily with the closely related species *S. boyacense* (clone *E.P.C.* 546), which also does not set berries on selfing. Berries containing a very large number of seeds are obtained from this cross and from the reciprocal. Also, as is shown in the table, F_1 plants from the cross are cross-compatible with either parent. It has not, however, been possible to show that only four types of F_1 plants, such as would be expected on a simple oppositional factor hypothesis, are produced.

	FEMALE PARENT					
MALE PARENT	*S. Rybinii*	*E.P.C.* 546	$F_1$4	$F_1$6	$F_1$8	$F_1$10
S. Rybinii	−	+	+	−	+	+
E.P.C. 546	+	−				
$F_1$4	+		−		−	
$F_1$6			+		−	+
$F_1$8	+	+	−	−	−	+
$F_1$10	+	+		−	+	−

+ = compatible pollination; − = incompatible pollination; $F_1$4, 6, 8, and 10 = F_1 (*S. Rybinii* × *E.P.C.* 546).

No berries have been obtained from selfing any of the clones of the blight-immune, Mexican diploid species *S. lanciforme* which was brought back by the Empire Potato Expedition as seeds. Berries containing numerous seeds have, however, been obtained from the following crosses between clones, *E.P.C.* 40·3 × 40·4, *E.P.C.* 40·3 × 40·7, *E.P.C.* 40·4 × 40·3, *E.P.C.* 40·6 × 40·3 and *E.P.C.* 40·6 × 40·4.

Similarly, two clones of *S. phureja*, *E.P.C.* 1307 and *E.P.C.* 1310, have never set berries on selfing, but berries with seeds were obtained from the cross *E.P.C.* 1310 female × *E.P.C.* 1307.

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Aug. 16.

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Effect of Sulphanilamides on the Growth of Micro-organisms in Presence and Absence of *p*-Aminobenzoic Acid

LAST year I presented some results of experiments on the antagonism between *p*-aminobenzoic acid and sulphanilamides (sulphanilamide, sulphapyridine and sulphathiazole) in autotrophic organisms[1]. These experiments were carried out with two strains of the freshwater diatom *Nitzschia palea* var. *debilis* (Kg.) Grun. I also made experiments on the inhibitory action of sulphanilamide on the growth of *N. communis* Rabenhorst, *N. Kützingiana* var. *exilis* Grun. (f. *multiplex*[2]) and further strains of *N. palea* var. *debilis*.

The growth of the diatoms, which were cultured on a substrate used by me[2] earlier[3] and known to be free from anti-sulphanilamide factors, was more inhibited by sulphanilamide than by sulphapyridine, which in turn had a somewhat stronger effect than sulphathiazole. In other words, the action of the sulphanilamides mentioned on the growth of the diatoms was the reverse of that on bacteria.

The antagonistic power of *p*-aminobenzoic acid on sulphanilamides in these experiments with diatoms was, however, similar to that in corresponding experiments with bacteria, the inhibitory activity being strongest against sulphanilamide, less strong against sulphapyridine and least against sulphathiazole. Although *p*-aminobenzoic acid probably is an essential metabolite (in the sense of Fildes[4]) for diatoms as well as for bacteria and fungi, the conditions—at least for the diatoms investigated—seemed to be more complicated, and it was assumed that the pyridine and thiazole groups of sulphapyridine and sulphathiazole made these influence also vital processes in the metabolism of the cell other than those connected with the *p*-aminobenzoic acid (cf. the opinion of West and Coburn[5] concerning the competition of sulphapyridine with nicotinic acid in the formation of coenzymes).

A connexion between my experiences with diatoms and the results from the investigations on bacteria was seen when Landy and Dicken[6] reported their experiments on the neutralization of sulphanilamides through *p*-aminobenzoic acid in yeast. Their growth diagram shows a crossing between the sulphanilamide and sulphapyridine curves, indicating that at certain higher concentrations of *p*-aminobenzoic acid the growth of yeast is less inhibited by sulphanilamide than by sulphapyridine, whereas at lower concentrations the reverse is true. This probably explains my own experiences with diatoms, although the response to sulphathiazole does not seem to be identical in the two groups of organisms.

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July 7.

Sten Wiedling.

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Rapid Determination of Fat in Animals and Plants

The living organism or tissue is weighed, preferably by the displacement method[1], and placed in a weighed Soxhlet thimble. It is then distilled under xylol, and the percentage of water estimated[2]. Any fat will remain in the xylol. A further extraction is carried out with xylol in the ordinary Soxhlet extractor and then the whole of the xylol used is made up to a litre or some other standard volume. Then 200 ml. of this xylol is placed in a round-bottomed flask together with about 200 ml. of distilled water and steam-distilled.

The vapour pressure of the xylol being well above that of steam and that of the fat being well below, the fat remains in the flask and the xylol is carried over. The water and fat from the flask are washed out into a separating funnel while still warm and allowed to cool. A small amount of hydrochloric acid is added to bring about demulsification and the whole is shaken up vigorously with petroleum ether. The fat dissolves and is estimated in the ordinary way by evaporating off the petroleum ether.

The method has been tested out thoroughly with lard and pure olive oil. It is obviously limited in its application but has the great advantage that it is unnecessary to dry the material containing the fat.

If a little of the original material is first steam distilled it will be seen at once if it contains volatile oils or fats and if it does the method is clearly unsuitable.

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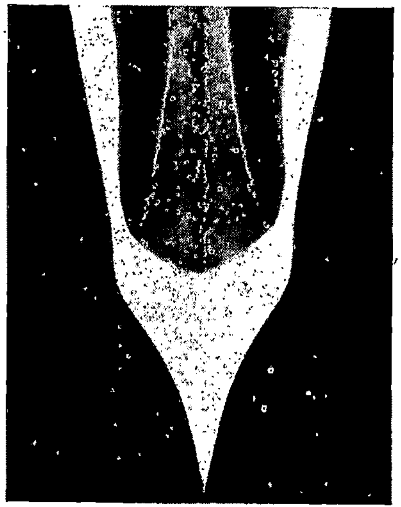
Luminous Radiation from Hot Gases

The question as to whether normal gases become luminous when heated is of the greatest importance to those interested in the physics and chemistry of flame gases. Pringsheim did a great deal of work with the view of deciding this, and found that they remained dark at the highest temperature he could command in the laboratory[1]. In recent books by Lewis and von Elbe[2] and Gaydon[3], however, doubt is expressed whether at temperatures of the order of 2,000° C. they would still remain dark.



I think there is no doubt that they would. Weston's spectrograms from carbon monoxide – air flame gases and the higher temperature carbon monoxide – oxygen flame gases show that when hydrogen is added, the characteristic carbon monoxide flame gas spectrum disappears—even though the flame gas temperature is higher[4]. The explanation would appear to be that, with addition of hydrogen, the carbon dioxide produced is much more normal, for it has been shown that the latent energy in carbon monoxide flame gases decreases with addition of hydrogen. (Gaydon suggests that the luminous radiation from carbon monoxide flame gases results from continual recombination after dissociation of the carbon dioxide. Weston's experiments do not appear to support this view, for a large amount of dissociation and recombination must be taking place in the high temperature carbon monoxide – hydrogen – oxygen flame gases.)

A further indication that hot normal carbon dioxide does not emit luminous radiation may be derived from flame photographs, which show remarkable variations in the intensity of the after-glow in carbon monoxide flame gases resulting from explosions in a glass tube. One such photograph taken by Dr. A. S. Leah is reproduced herewith. His experiments have shown that the temperature of the gases showing almost negligible after-glow is higher than that of the gases in the immediate neighbourhood which show a strong after-glow. There can be little doubt that the carbon dioxide in the former gases is much more normal than the carbon dioxide in the latter gases[5].

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August 12.

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Diffraction of Ultra-Short Radio Waves

WE have pointed out[1] that ultra-short radio waves polarized with the electric vector vertical are propagated into the shadow of hills more readily than horizontally polarized waves. We have since observed the opposite effect for receiver positions beyond hills but just outside their shadow. Fig. 1 represents roughly the terrain over which these results, shown in the table, were obtained. The transmitter *T* was near the top of one ridge and the field strength investigated over the region *ABCD*; horizontally and vertically polarized radiation was emitted in turn from the transmitter on a wave-length of 3 metres, and the aerial at the receiver oriented to correspond for each measurement with the appropriate transmitter polarization. Over the region *ABC* within the geometrical shadow of the ridge having a crest at *A*, the vertical electric field, in agreement with our earlier note, was greater than the horizontal field, the ratio of these two fields, as will be seen from the table, being unity near the edge of the shadow at *A* and *C* and a maximum near the bottom of the valley at *B*. Just outside, however, the horizontal field was greater than the vertical, the ratio showing a flat maximum.

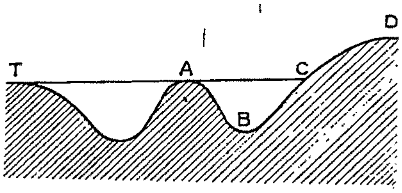

Fig. 1.

These experimental results are similar to those found both theoretically[2] and experimentally[3] in the diffraction by a straight edge or wedge of radiation in the visible spectrum. As the radius of the curvature of the ridge in our experiments was large compared with the wave-length, similar results would be obtained if the obstruction caused by the ridge is assumed to represent that due to the earth's curvature. It may be concluded, therefore, that for an elevated transmitter *T* (Fig. 2) and receiver positions within the shadow *ABC* cast by the earth's curvature, vertical polarization should be used, but for positions just outside that shadow, horizontal polarization is more efficient. Horizontal polarization may, in practice, be the better for transmitter and receiver positions such as *T* and *R* (Fig. 2) well within optical range of one another if *R* is at such a height as to be just outside the shadow caused by the continuous diffraction due to undulation of the ground, houses, etc. In addition, horizontally polarized radiation may be better over tree-clad country, under the above conditions, on account of the materially greater attenuation caused by trees to vertically polarized radiation at ultra-short wave-lengths.

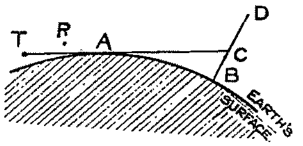

Fig. 2.

Position	Field-strength in microvolts per metre		Ratio Vertical/ Horizontal fields	Remarks	
	Vertical polarization	Horizontal polarization			
1	32,000	31,000	1·03	Position *A*	in shadow
2	6,300	4,100	1·54		
3	2,500	950	2·63		
4	1,200	500	2·40		
5	1,080	530	2·04	Position *B*	
6	1,900	1,400	1·36		
7	7,900	8,400	0·94	Position *C*	outside shadow
8	9,800	11,500	0·85		
9	12,000	19,700	0·61		
10	9,800	17,500	0·56		
11	6,500	9,800	0·66		
12	2,000	2,220	0·90		
13	740	710	1·04	Position *D*	

The work described above was carried out as part of the programme of the Radio Research Board, to which this note was first circulated as a confidential report, on March 11, 1940. It is now published by permission of the Department of Scientific and Industrial Research.

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Frequency of Dust-storms in the Egyptian Desert

WHEN I reviewed[1] the book by Lieut.-Colonel R. A. Bagnold on the "Physics of Desert Sands and Dunes", I noted a statement by the author that dust-storms, as distinct from sand-storms, were of comparatively rare occurrence in the Egyptian desert, whereas dust-storms were being reported in the news as interfering with the fighting in the Middle East every few days. At the time, I regarded the term 'dust-storm' as being somewhat loosely applied by the reporters, and to include sand-storms, but I have recently had the opportunity of reading a paper[2] by Prof. F. W. Oliver which throws new light on this point. Prof. Oliver has lived since 1935 at Burg-el-Arab, thirty miles west of Alexandria, and he states that changes have occurred in recent times. The average dust-storm frequency from 1935 to 1939 was 5 a year over the period January to May; in the same period of 1940 there were 8, and in 1941 there were 32 storms. The total number for the year 1941 was 54, and in addition to the increased frequency, the severity was much greater.

Prof. Oliver accounts for this increased frequency first by the surface disturbance caused by war operations in the desert, such as construction of fortifications and movement of lorries; and secondly, by the removal of cover, that is, desert scrub, which was destroyed by the Bedouins when they evacuated from the district. He considers that extensive measures will need to be taken after the War to abolish the dust nuisance in these districts.

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[1] NATURE, 48, 480 (1941).

[2] "Some Remarks on Desert Dust-Storms". By F. W. Oliver. Pp. 16. (Alexandria: Whitehead Morris (Egypt), Ltd., 1942.)

Social Reporting

IN the review of Mass-Observation's recent report "People in Production"[1], the main theme of this report seems to have escaped the reviewer's attention.

What "People in Production", a report on six months study in war factories, analyses out is a fundamental psychological tendency of our present civilization, seldom realized or studied—the 'quantitative approach'. The idea that you are doing well by producing a lot of things, by having so many tanks brought off the production lines every day; so many Flying Fortresses flown across the Atlantic every week; such and such an enormous percentage of men conscripted into the Forces, and of women directed into industry; long hours of work; impressive figures of war money expenditure—these have been the common encouragements of Lord Beaverbrook, Mr. Lyttelton, Mr. Bevin and others. Our production study attempted to show how this heavily quantitative approach has led to a neglect of qualitative considerations. These qualitative considerations are of two main types—the quality of the materials produced, and the quality of the personnel dealing with the product. The former type lies outside the realm of sociology, but no one who has read *Hansard* on the two days of the recent Censure Debate, including Mr. Lyttelton's speech, can doubt that there has been some muddled thinking on this side. We were concerned with the latter type.

We found over and over again that the qualitative, social and psychological factors were being ignored. The underlying assumption in war industry and in the Services, all the way through, is that men and women are units of subsidiary importance to machines, yet with many mechanical attributes. The qualitative human factors, which distinguish a soldier from a rifle, a working girl from a capstan lathe, are ignored to a surprising extent. This leads to many avoidable inadequacies. To put it in its simplest form: it does not matter how many tanks you have in Libya, or even how good they are, if the people handling them are not fully tank-minded, tank-educated, and tank-determined. Lots and lots of everything will not win anything. It is the human element, both in producing and in *using* the products which will determine the outcome of the War. This elementary point has been astonishingly ignored. It is not so astonishing, however, if it is related to the growth of industry, with its economic and numerical incentives, and this, too, we have tried to trace out in "The People in Production". The statistical obsession of the social sciences has also contributed to a neglect of the real, *human* factors.

Such material is certainly topical, and as such might, I suppose, be called 'social reporting'. But even the social sciences cannot stand above the battle. With complacency, the reviewer concludes that our study shows how "countless relatively small mistakes are being made everywhere, an ordinary state of human affairs". We cannot, at present, afford to be ordinary. The "countless relatively small mistakes" are related to a central theme, which requires analysis. What a negation of sociology to dismiss it as merely an ordinary human state: what is social science about if not that? I for one am happy to be called superficial if in being so I am helping to illuminate the mentality of the present and to preserve the integrity of the future, however inadequately.

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[1] NATURE, 149, 711 (1942).

THE review to which Mr. Harrisson objects made it abundantly clear that the report was concerned with "the quality of the personnel dealing with the product". Ten topics of the report were mentioned, all of which dealt with qualitative, social and psychological factors. The comment was made "Emerging from the survey of most of these problems is the evident need for everybody to understand more fully what other people are doing and the conditions of their work. The Fighting Services, the Supply Ministries, management, foremen and workers all need to know more about each other. Extensive reporting of the kind offered here is one means of fulfilling the need."

What Mr. Harrisson misunderstood as my complacency about the "ordinary state of human affairs" might better have been called pessimism, except that I believe it to apply to the state of enemy affairs as well as our own. To say that the small mistakes are related to a central theme is either a truism (since everything which happens in a social group is related to some vague central theme), or else it implies a dubious political or sociological dogma, as I supposed from Mr. Harrisson's remark, "*Something* is seriously wrong somewhere". THE REVIEWER.

RESEARCH ITEMS

Lipoid Compounds in Physiological Processes

THE importance of lipoid compounds in physiological processes such as blood clotting, in which prothrombin is activated by thrombokinase, a kephalin protein complex, or in immunological reactions where lipoid 'haptens' are assumed to join up with protein in the blood to form true antigens, is being increasingly realized. The Food Investigation Board of the Department of Scientific and Industrial Research has just issued Food Investigation Report No. 52—"The Mode of Occurrence of Fatty Acid Derivatives in Living Tissues"—by J. A. Lovern, Torry Research Station (H.M. Stationery Office. Pp. 36). This deals with the types of fatty acid derivatives occurring in lipoidal extracts, with the dynamic state of lipoids in the tissues and mainly with the lipoid-protein and lipoid-carbohydrate complexes of animals and plants. The available evidence concerning these complexes is considered according to the experimental methods used—physical methods (histological, physical determinations), physiological studies (blood clotting, antigenic reactions), solvent extraction of tissues (animal tissues, vegetable tissues), experimental preparation of lipoid-containing complexes, isolation of natural lipoid complexes, lipoprotein 'gliodes'. Comment is made on methods of splitting certain lipoproteins which may have a more general application in displacing acidic prosthetic groups from protein carriers. By adding a highly basic protein such as salmine, the phosphatide is detached, forming a phosphatide-salmine complex and leaving the original protein free and undenatured. Conversely, the addition of heparin with the formation of a heparin protein complex leaves the lipoid free. There is evidence of more than one type of lipoid-protein and lipoid-carbohydrate linkage, ranging from mere adsorption to complexes to definite chemical compounds which can be split only by drastic chemical action. An example of the latter is a lipoprotein from horse serum which is completely soluble in water, contains 22·7 per cent phosphatides, 17·9 per cent cholesterol esters and 59·1 per cent of a protein having the properties of an albumin. In spite of this high lipoid content, ether only extracts mere traces of lipoids from its aqueous solutions.

Bean and Dock Aphides

UNDER the title of "A Description of *Aphis (Doralis) rumicis* L. and comparison with *Aphis (Doralis) fabæ* Scop." Margaret E. Jones contributes the results of investigations on these two species to the April issue of the *Bulletin of Entomological Research*, 33, 1 (1942). Both species are black in colour and both occur on species of dock (Rumex), with the result that much confusion prevails regarding their identity. *Aphis rumicis*, it is pointed out, is monophagous and confined to that host plant, while *A. fabæ* is polyphagous and is the well-known 'black fly' that infests the broad bean. *A. rumicis* is non-migratory whereas *A fabæ* over-winters on other plant-hosts, namely, Euonymus and *Viburnum Opulus*. The sexuales individuals in the two species are very distinct, the males of *rumicis* being apterous and those of *fabæ* are winged. In the case of the oviparous females those of *fabæ* have broad hind tibiæ plentifully endowed with sensoria. whereas the oviparous forms of *rumicis* have slender hind tibiæ bearing very few sensoria. Differences between the two species regarding the viviparous forms are also described and the paper contains a number of explanatory text-figures.

Plant Oils as Insecticides

A TECHNICAL BULLETIN, No. 801, February, 1942, has been issued by the United States Department of Agriculture (Washington, D.C.), entitled "Insecticidal Efficiency of some Oils of Plant Origin", by A. W. Cressman and Lynn H. Dawsey. Oils may be classified into three groups according to origin—plant, animal and mineral. Oils of the last type, especially petroleum oils, have found wide utility in insect control, most of the American investigations being based on this class. The trouble with these oils has been the injurious effects which may be produced on the plants to be protected. For foliage sprays, plant oils would reduce this danger. The authors compared the insecticidal efficiencies of a number of oils of plant origin with that of a refined petroleum oil. Emulsions were prepared by mixing these oils with ground bone glue in a high-speed drink mixer. Tests, for which the Bulletin must be consulted, were carried out on Mexican mealy bugs reared on potted chrysanthemum plants in the greenhouse, which were sprayed in the laboratory. Mature females and eggs of the willow scurfy scale on willow twigs and fruit-tree leaf roller eggs on apple twigs were collected in the field and brought to the laboratory for treatment. Oils experimented with were crude corn oil, crude cottonseed and pea-nut oils and their refined stages, also orange and pine oils. It is stated that "Although vegetable oils are generally higher priced than petroleum oils, they possess superior solvent action for certain organic insecticides, and may find new uses because of this property".

Insects and Azalea Flower Spot

A TECHNICAL BULLETIN, No. 798, January, 1942, entitled "Relationship of Insects to the Spread of Azalea Flower Spot", by F. F. Smith and F. Weiss, has been issued by the U.S. Department of Agriculture (Washington, D.C.). The investigations were carried out between 1934 and 1938. It was found that five species of bumble bees (Bombus spp.), two species of carpenter bees (Xylocopa spp.), *Emphoropsis floridana*, and the honey bee, *Apis mellifera*, are the most conspicuous visitors, although thrips, flies and many others come to the flower. It is concluded that, while insects are at times efficient vectors of the organism, they are not primarily responsible for the development of the disease when once it has become established in a given planting. They may, however, be concerned with its spread to nearby plantings of azaleas. Controlling the disease, rather than the insects, therefore appears to be the logical means of attacking the problem, a method which has to be attempted so often by the forester as well as the horticulturist.

Plant Diseases in Scotland

R. W. G. Dennis and C. E. Foister publish a long list of plant diseases found in Scotland (*Trans. Mycol. Soc.*, 25, Pt. 3; June, 1942). An important feature of the paper is the demonstration that several plant parasites common in England are not abundant north of the border. Downy mildews are scarce, except those caused by *Peronospora parasitica* and *Phytophthora infestans*. Rots due to *Sclerotinia sclerotiorum* are seldom encountered; white root rot, *Rosellinia necatrix*, has not been reported, and violet root rot, *Helicobasidium purpureum*, is rare. Such common English cereal maladies as *Puccinia triticina*, *Ophiobolus graminis* and *Septoria Tritici* are either unknown or are seldom discovered. Scotland has the doubtful distinction of having been the channel of introduction of *Puccinia mirabilissima* on *Mahonia aquifolia* to other parts of the British Isles, but there appear to be very few diseases which are widespread in Scotland and absent from England—a fact of undoubted importance in the ecology of fungi.

Bacterial Canker of the Peach

A SHORT paper by H. Wormald (*Trans. Brit. Mycol. Soc.*, 25, Pt. 3; June, 1942) describes a bacterial canker of the peach caused by *Pseudomonas mors-prunorum*. The disease kills infected branches and discolours the cortex. Pathogenicity has been established by inoculation, but the malady is fortunately not very widespread at present.

Genetics of Mating in Euplotes

R. F. KIMBALL (*Genetics*, 27, 269; 1942) has discovered a multiple allelomorph series which controls conjugation in *Euplotes partella*. Six lines (or types) descended from two individuals will not generally mate within themselves but will mate with each other. An allelomorph series controls each mating in such a way that individuals carrying similar genes of this series do not conjugate. Types III, IV and VI are homozygous for the three members of the multiple allelomorph series, and types I, II and V are heterozygotes. It was found that animal-free fluid from one mating type may induce matings of animals of different type. Further investigation shows that fluid from a heterozygous type induces mating in the remaining five types, but from a homozygous type induction of mating only occurs in those types which do not have an allelomorph in common. There are aberrations in the data, such as unexpected matings within a type and failure of conjugation where it is expected; but the general scheme is coherent and further work is proceeding to analyse the exceptions. It is noteworthy that the allelomorphs produced qualitatively different substances which induce mating, and that in the heterozygote the allelomorphs are independent and not conjoint in action.

Crystal Structure of Cobalt

THE X-ray photographs obtained from cobalt depend markedly upon the previous history of the particular specimens used. The same powder photograph may include face-centred-cubic and close-packed-hexagonal lines. While this two-phase state has generally been ascribed to the presence of impurities, O. S. Edwards and H. Lipson have obtained similar photographs from cobalt of 99·99 per cent purity (*Proc. Roy. Soc.*, A, 180, 268; 1942). The photographs show a remarkable mixture of sharp and diffuse lines. The sharp lines have $\frac{1}{3}(h-k)$ integral or l zero. All others are more or less diffuse. An explanation of this is produced, based on the possibility of 'faults' occurring in the structure, because there are two different ways in which one close-packed layer of atoms can be fitted on to another. It is shown theoretically that if such faults are repeated at regular intervals the reflexions with $\frac{1}{3}(h-k)$ integral are not affected, but the positions and intensities of the other lines are modified although they remain sharp. A structure with random faults would give on powder photograph broadened reflexions except for lines with l zero. A mathematical treatment of the proposed structure is given by A. J. C. Wison (*loc. cit.*, p. 277). The frequency of faults in the specimen used in the experiments is found to be, on the average, about one in every ten planes.

Free Radical Chain Reaction

A STUDY of the detection and inhibition of free radical chain reactions has been made by J. R. E. Smith and C. N. Hinshelwood (*Proc. Roy. Soc.*, A, 180, 237; 1942), comparing nitric oxide and propylene as inhibitors. Inhibition curves for the thermal decomposition of diethyl ether in the presence of propylene and of propaldehyde in the presence of propylene are given. An examination of the influence of propylene and of nitric acid on the thermal decomposition of acetaldehyde forms Part IV of the series of experiments, which concludes with a comparison of a series of aldehydes.

Thermal Vibrations and X-Ray Scattering

MISS K. SARGINSON has continued her theoretical study of the effect of thermal vibrations on the scattering of X-rays (*Proc. Roy. Soc.*, A, 180, 305; 1942). The previous work on background scattering is developed in detail. Only the acoustical branches of the elastic spectrum can produce extra spots. The properties of an extra spot near a Laue spot can be derived from the elastic constants of the crystal, and explicit formulæ for the position and shape of the spots are given for cubic crystals with diagonal lattices. The applicability of the theory to Lonsdale and Smith's 'secondary spots' needs a special investigation.

Autelectronic Emission from Single Crystal Metal Points

FROM the research laboratories of the General Electric Co. a further instalment of the work on the distribution of autelectronic emission from single crystal metal points is presented by M. Benjamin and R. O. Jenkins (*Proc. Roy. Soc.*, A, 180, 225; 1942). The adsorption, migration and evaporation of thorium, barium and sodium deposited on tungsten and molybdenum are here dealt with. Migration occurs at relatively low temperatures, and for an optimum thermionic covering there is a unique distribution of the migrating atoms on the metal crystal. Certain crystal zones, are avoided by the migrating atoms. The atoms evaporate more readily from certain crystal zones, and the differences in temperature for complete migration and evaporation of the atoms lead to an explanation of the failure sometimes to observe migration with barium, from multicrystalline surfaces, where the difference between migration and evaporation energy is small. With thorium, where the differences are much greater, the migration is always observed. In the studies of thorium on tungsten and thoriated tungsten, it is found that the diffusion occurs through the crystal lattice along certain preferred directions. The final distribution of thorium is identical with that obtained by depositing thorium from an external source. The paper is illustrated by an extensive series of photographs with their interpretation superimposed on transparent paper. (Since the work was completed, Dr. Benjamin has been killed in a flying accident.)

THE DISCRIMINATION METHOD IN ANIMAL PSYCHOLOGY

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THE fact that an animal is able to discriminate between two stimuli is the foundation of a method used extensively in animal psychology. It is, however, open to various sources of error. While looking through a number of papers dealing with this method I found that some of these possible pitfalls are often not sufficiently realized.

(1) The danger of influencing the animal's choice by signs given unconsciously by the experimenter is well known. It is scarcely existent in lower vertebrates and probably absent in invertebrates. In the case of mammals and birds, however, it is still underrated. Often it is not the experimenter but the apparatus used that gives the secondary cue. Bingham[1] has told with admirable sincerity how his birds "outguessed" him in experiments on discrimination between two illuminated circles of different size, one of which had a constant diameter and the other a variable diameter. The position of both circles was constantly but irregularly changed to avoid training to position. The birds surprised the experimenter by their ability to discriminate between very slight differences in area. When they were able to discriminate between two circles of 59 and 60 mm. diameter respectively, Bingham became suspicious and made both circles equal. Even then the birds were able to discriminate between the variable and the standard circle, and it turned out that the cue was a scarcely visible streak of light caused by a minute crack of the box containing the electric bulb which illuminated the standard area.

While in many cases the experimenter becomes aware of the cue guiding the reactions of his animals, this source of error is often overlooked. The most striking results obtained in work with the so-called 'multiple-choice' method and quoted for years in all papers dealing with this problem are in all probability due to secondary cues, as I have pointed out elsewhere[2].

(2) Even in the absence of all crude secondary cues, and I have mentioned only one possibility out of very many, there is always the danger that the animals in question will discriminate between the two stimuli in a way differing completely from the experimenter's assumption. Very frequently errors are caused by the confusion of the objective stimulus with its subjective equivalent; for example, brightness, being a purely subjective concept, cannot be measured in objective physical units as intensity of radiation (=heat equivalent). Two colours, which have the same brightness for us under a certain condition of adaptation, etc., acquire a different brightness for ourselves when the objective intensity of both of them is reduced to a fraction of the previous values. This is a well-known fact, but it is often overlooked that the ratio of brightness might change in quite a different way for animals in exactly the same circumstances. Thus in many papers dealing with the 'discrimination of colours' the animals in question may have only distinguished between different intensities of light, instead of different wave-lengths.

(3) Apart from these possibilities, there is still another source of error in discrimination tests: an error in the interpretation of the motives responsible for the animals' choice. As this is a matter of primary importance, misjudgment in this respect appears especially dangerous. The simplest way to deal with this problem is to give a concrete example taken from Bierens de Haan's "Animal Psychology for Biologists"[3]. This very experienced and careful worker, by means of a typical discrimination method, trained a monkey to find food behind a door marked with a red circle. There was no food behind a second door showing a blue triangle. He gives the following description of his experiments (p. 41): "When the animal was well trained, I changed the blue triangle for a blue circle or a red triangle, leaving the red circle as it was. Had it been trained to go simply to the red circle, as I supposed it was, then there would have been no reason for the monkey to make errors now, as the red circle remained visible as before. Instead of this, the animal now made about 50 per cent errors—that is, it was quite confused. The only possible explanation of this sudden confusion, as all other circumstances remained the same, is that the animal was not trained simply to go to the red circle, but to go to the red circle in opposition to the blue triangle, so that, when this latter figure was changed, the red circle lost its meaning as a guide to the food. As soon as I showed the former combination of figures, the animal was again at home, and made no more errors."

E. S. Russell, in his "Behaviour of Animals"[4], has quoted the same passage as a typical example for a reaction "where the response was to complexes rather than to single features of the perceptual field".

I cannot agree with the interpretation that here the "complex effect" of the two stimuli is the "only possible explanation". It is quite possible that the animal had not learned to open the door with the red circle, but only to avoid the one marked with the blue triangle. The blue triangle, however, was not used again in Bierens de Haan's control tests. They were therefore incomplete, and should have been supplemented by offering the blue triangle (the negative sign) in conjunction with one of the signs not used for the training—the blue circle or the red triangle.

There is still another point. When only the blue triangle had obtained a "valence" (this valuable term has been introduced by E. S. Russell into animal psychology) for the monkey, in this case a negative valence, we should not expect the animal to be confused when this sign was absent, but just an unrestricted selection of the two doors according to chance as neither was significantly marked for the animal. If we now look back to the description of Bierens de Haan's experiments in his original paper[5] we find indeed no "confusion", which would manifest itself in hesitation or even refusal to make any choice, but just the contrary. Bierens de Haan says here (p. 730) that he found it most surprising that the monkey showed so little hesitation, when the positive sign was missing, and in most cases it made its choice at once when the screen covering the apparatus was lifted "as if nothing had been altered in the experimental conditions". This confirms my opinion that here only the negative sign had obtained a valence for the animal, and actually there was no confusion and no reason whatever for the monkey to hesitate when this sign was missing. As the two other stimuli had no valence—either positive or negative—they were selected without preference and thus the

50 per cent "errors" of the monkey are fully explained without the necessity of assuming a complex effect.

One could object to this explanation that it is improbable that a negative sign would obtain a decisive valence although there was no punishment, while there was a reward (food) in the case of the positive sign. This, however, is by no means uncommon. It is very instructive to compare these results with experiments carried out much earlier by Breed.[6] This author trained fowls to discriminate between colours, for example, black from blue. When selecting blue the birds were punished by an electric shock, while in the case of a correct choice (black) the only reward was that the birds could see or join their companions again. As the negative stimulus was here the "emphatic" one, Breed expected that the birds would react indifferently when the negative sign was replaced by a new one—and so it was, at least in the majority of the cases. Even the brightness of the colours did not matter at all as these birds reacted in the same way to white-blue as to black-blue—the response being one of "getting-away-from-the-blue-no-matter-what-the-other-colour." But this did not happen in all cases, for Breed found to his surprise in three out of eight birds that they responded "definitely and positively" to black, but not negatively to blue. These three birds were quite lost when white accompanied blue, although the training procedure had been exactly the same in both cases. "With these chicks black (+) seemed to be the guiding stimulus" (p. 69), that is, they acted only according to the positive sign although this was not the emphatic one.

Breed tried to summarize his results in a general statement. He was perhaps not quite fortunate in expressing it in the following words (p. 78): "Psychologically, it seems, negation is not affirmation". Apparently he wanted to say that if we train an animal to discriminate between two stimuli, the creation of a negative valence for one of them does not necessarily mean that the other one obtains automatically a positive valence for the subject in question—and vice versa. The importance of this fact for experimental work on discrimination is obvious.

To avoid any misunderstanding, I should mention that often a complex effect can indeed be primarily decisive in discrimination tests, for one need only recall the well-known experiments carried out by W. Köhler[7] on the "structural function" (the relative choice) present in the domestic fowl and chimpanzee. Here the response was definitely to a relation between two stimuli (for example, between two different shades of grey), but Köhler was much too careful to claim that this was the only possible way of learning. The learning effect fixed to absolute characters is in his opinion only of short duration, while the effect of the "structure of the pair" is better fixed. This difference in fixation, however, is by no means sufficiently examined and would no doubt provide material for interesting psychological work. For the time being we have therefore in every discrimination test to examine not only the effect of the pair, but also of each of its single components.

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[1] Bingham, Harold C., *Behav. Monogr.*, **4**, No. 4, 1 (1922).

[2] Honigmann, H., *Biol. Rev.*, **17**, No. 4 (1942).

[3] Bierens de Haan, J. A., "Animal Psychology for Biologists" (London, 1929).

[4] Russell, E. S., "The Behaviour of Animals" (London, 1934).

[5] Bierens de Haan, J. A., *Biol. Zbl.*, **45**, 727 (1925).

[6] Breed, Frederick S., *Behav. Monogr.*, **1**, No. 2, 1 (1911).

[7] Köhler, W., *Abh. Preuss. Akad. Wiss., Phys.-Math. Kl.*, **1** (1918).

RECONSTRUCTION IN OXFORD AND LIVERPOOL

THE second part of the report of the Committee on Planning and Reconstruction of the Oxford Preservation Trust, which has recently been issued, makes a number of detailed recommendations. Turning first to the new civic centre, it is recommended that it should be located where the three roads from Headington, Iffley and Cowley converge, a sufficient area being also allocated for a proper shopping centre for the eastern half of Oxford, including a new covered market. The St. Ebbe's area should be replanned, the greater part of the site of the Oxford Prison, including the Castle Mound, being made into a public park. In the western section a new joint railway station should replace the present inconvenient and unsightly structures. In the central section the covered market should be removed, and possibly two new markets substituted, one in Castle Street and the other in East Oxford. Gloucester Green might become a square for shops and offices, while Holywell with Merton Street should preserve its present character.

In regard to surrounding towns and villages, Kidlington should become more self-contained, with better shops and social amenities. A number of villages in the vicinity of Oxford should be protected from industrialization and objectionable building, but there are in the district country towns which might welcome the advent of new light industries. The beginning of a protective girdle of open land around Oxford already exists, but early action is necessary to protect from building development a number of farms and playing-fields on the fringe of existing suburbs, together with several stretches of hill and woodland. This will involve some purchase of land in the public interest, but much will continue in use for agriculture, including market gardening.

To relieve the congestion in the centre of the city, it is essential to complete the northern and southern by-passes at the earliest date possible after the War. The northern section of an inner circular road which has also been under consideration by the City Council, with a new bridge over the Cherwell near the southern end of Mesopotamia Walk, would also be an advantage, but the difficult questions raised by the alignment of the southern section might be left for further consideration until the effect upon traffic of the various other measures contemplated becomes apparent. Other recommendations include a greater use of Cowley Station for passenger and goods traffic, doubling the single-track line to Princes Risborough, with an alternative fast railway service to London and elsewhere; provision of numerous public walks; improvements in the confused waterway system; proper control over the design of new or restored buildings, and the preservation of old houses remaining in the area of the medieval city; and adequate amenities, including a building for a proper health centre.

The post-war reconstruction of Liverpool was the subject of an address by Alderman A. E. Shennan, which has been published by the Liverpool Council of Social Service and the Merseyside Civic Society. The extensive damage which Liverpool has suffered from the numerous air raids has given it an opportunity of re-planning which it could not otherwise have hoped to see, and in commending Alderman Shennan's bold scheme, the Lord Mayor points out in a foreword that it provides a plan of central Liverpool which would make it a place worthy of the coming needs of post-war building on a grand scale. The broad street or avenue making a circuit from pier-head to pier-head, connecting the three railway stations and forming a ring from which traffic could easily move to the outskirts without crowding the centre as at present, would give an importance to the inner section of the City which it sadly lacks to-day. Moreover, the re-planning of the pier-head itself would give Liverpool at last a water-front of which it might be proud, and through which it would proudly welcome travellers from all parts of the globe.

The first proposal covers the dock area, whereby the Dock Road, north of its junction with King Edward Street, would virtually become a private service road on a combined dock and railway estate, extending the existing dock estate eastwards to Derby Road and Great Howard Street. These two roads would be converted into a wide artery capable of carrying all north- and south-bound through traffic along the line of the North Docks, and the Overhead Railway would be replaced by a more mobile system of passenger traffic.

A major item in the plan is an inner ring road which is regarded as the proposal which could confer the greatest benefit to the heart of Liverpool. It is a feature missing in the natural development of most towns. It would give added importance to Exchange Station, and the scope for architectural treatment which the expansion of the railway termini afford is greatly stressed by Alderman Shennan. There would be a direct connexion between Exchange Station and the Lord Street–Church Street shopping centre, while the proposals for the new civic centre, the heart of which is the tunnel entrance, provide for the reservation of the St. John's Lane frontage for civic buildings, to balance the Museum and Art Gallery, and to complete the growing of the stately beauty of St. George's Hall, while on the western side, buildings connected with the administration of the City would be sited.

The town hall, the two cathedrals and the pier-head are the subject of other planning proposals, and the scheme contemplates a general rectification of the existing street plan, control by zoning, provision of industrial sites, open spaces and linking the parks. The plan involves a long-term as well as a short-term policy.

There is no reason to doubt the ability of the people of Great Britain to seize the opportunities of re-planning which the War has given us, and these two examples of plans show a vision and vigour which are the best safeguard against the apathy and selfishness which led to London missing its opportunity of nearly three centuries ago.

ELECTRICAL PRODUCTION OF BULLET-PROOF STEEL

THE manufacture of bullet-proof steel is surveyed in an article by A. G. Arend in the *Electrician* of July 31. Formerly intended for helmets, bullet-proof steel was also made for breastplates in the closing stages of the War of 1914–18. When the latter were first proposed, a manganese-vanadium steel was employed containing some 0·90 per cent of manganese and 0·20 per cent of vanadium, and was prepared in Heroult three-phase electric furnacess Despite the purest possible metal being produced, results were not uniform, and a manganese steel was substituted containing 12 per cent of manganese, and 1 per cent of carbon.

Little has been done in the intervening years in the way of development, although vanadium steels have found extended use in automobile production. A maximum of 0·02 per cent is allowed for both sulphur and phosphorus; the small range of the other constituents precludes the use of anything but the absolute precision of control peculiar to the electric furnace. The vanadium constituent is important, and although ranging only from 0·15 to 0·25 per cent content, it allows of a light strong steel. The last approved bullet-proof steel, prepared in 6-ton Heroult furnaces, contained 2 per cent nickel, 1 per cent manganese, 0·20 per cent vanadium, 0·20 per cent silicon, 0·02 per cent phosphorus, 0·02 per cent sulphur and 0·42 per cent carbon. The admissible error was 0·05 per cent except with sulphur and phosphorus, which could not exceed the 0·02 per cent maximum.

The furnaces were not then equipped with automatic arc regulation, and gave trouble in the initial melting of scrap. Present-day furnaces are of smaller capacity and bottom connexions are omitted in the larger sizes to avoid the formation of cracks. Water cooling of bottom connexions, so far as the hearth is concerned, is now regarded as potentially dangerous.

There is a choice of design to-day between the direct arc and arc-resistance types of furnaces, the latter being preferred when a smaller charge suffices. Troubles with the smaller electrodes for 1-ton hearths resulted in the use of two-phase furnaces with bottom connexions, the current being supplied through Scott connected transformers. In comparison with the low operating voltages used for plain carbon steels, supply is usually switched on at 110 volts: with the cold scrap used in the charge, surging can momentarily raise the current as high as 10,000 amp. Since the refining period tends to vary, the energy consumption ranges from 750 to 825 kwh. per ton.

The carbon content following de-phosphorizing should be about 0·300 per cent, with the actual phosphorus below 0·02 per cent. Tapping temperature is important and after final additions have been made to the melt, it is only allowed to remain in the ladle long enough for the slag to rise properly, whereupon it is cast into ingots of about 8 in. by 14 in. cross-section, care being taken to avoid undue strains from shrinkage by chilling. Ingots are then rolled and shaped as required, undergoing any necessary heat treatment.

During 1914–18, two test methods were available for helmets and breastplates. The former, which were of 0·035 in. sheet, were subjected to the impact at 10 ft. of a bullet fired from a 0·44 Colt revolver with a muzzle velocity of 840 ft./sec. The breastplates, of 0·175 in. thickness, were expected to withstand the impact of a copper-sheathed rifle bullet fired at 50 yd. with a muzzle velocity of 2,140 ft./sec. In the former case the metal was considered to be satisfactory if the bullet did not make a dent of more than 0·5 in. in depth and 3·5 in. in diameter. Successful production of bullet-proof steel largely depends upon systematic furnace operation, and it is imperative that all electrical connexions function with precision to permit of continuous uniform working without temporary stoppages.

MANUFACTURE OF FERTILIZER FROM URBAN WASTES

By GEORGE BRANSBY WILLIAMS

THE importance of organic fertilizer in maintaining the humus content of soils, which is essential for growing crops in a healthy condition, is now widely recognized. Many definitions of the nature and functions of humus have been given, but the most practical is that given by Mr. G. V. Jacks in a paper read before the Royal Society of Arts on February 12, 1941; he said, "Humus does many things all of which can be summed up in the statement that it makes a mass of otherwise dead rock particles a suitable habitat for living plants. It is the substance which distinguishes soil from a mere geological deposit." The luxuriant growths produced by artificial fertilizers deplete humus of its essential elements unless an adequate supply of suitable organic manure is used to restore them.

It has for a long time been generally assumed that it is impossible to feed more than a fraction of the population of Great Britain on home-grown food, and the nation has resigned itself to seeing agriculture slowly decay until in many parts of the country landowners and farmers have been more concerned with the value of the land for building than with its fertility. Actually it seems that there would be no physical difficulty in growing the greater part of the food we require in our own country. The production of home produce has been in normal times an economic question, but in war-time it has become a vital matter on which the survival of the nation may depend.

If the quantity of food produced in Great Britain is vital, then so is the supply of an adequate supply of organic fertilizer. Both house refuse, and the sludge that settles out of domestic sewage, contain considerable quantities of organic matter that can be converted into humus by simple methods in a longer or shorter period. Sir Albert Howard has estimated that there is 10,000,000 tons of refuse in the controlled tips around the cities of Great Britain, and hundreds of thousands of tons of fresh house refuse are being removed from the urban areas each year. Much of this refuse is incinerated and its organic fertilizing ingredients destroyed, and the problem of finding waste land on which to tip the remainder is yearly becoming a more difficult one. The matter in the sewage amounts to nearly another million tons per year. A portion of this is discharged into the sea, and considerable expense is incurred annually in disposing of the rest by drying, pressing, trenching or digesting.

These materials, as first produced, are not in a suitable condition for application to the land, but they can be transformed into humus by composting. The system of composting urban wastes had its early development in India. Mr. R. D. Anstead related in a paper read in 1932 how, in the first instance, simple waste products, such as leaves, weeds, old straw and the like, were fermented. This method proved so successful that Dr. Fowler and others turned their attention to dealing with the refuse of Indian cities in the same way. The high temperature of initial fermentation kills all fly larvæ and all weed seeds.

Ordinary sedimentation tank sludge can be used. It has also been found that cover is not essential, for the process can be carried on very successfully in the open.

The large amount of cellulose in pulverized house refuse is just what is needed by the fungi and bacteria which synthesize microbial tissue in a manure heap.

A process for converting household refuse into fertilizer by inoculating it with a bacterial culture has been evolved by the Hyganic Company and is in operation on a large scale at the Kensington Borough Works in Wood Lane, London. Here it deals with about 100 tons of refuse per day from 180,000 persons. The process is rapid in action, but as exemplified at Wood Lane is expensive.

Simple composting or mixing in heaps on a concrete floor as carried out at Maidenhead is cheaper. The process of manufacture of the fertilizer is carried on at the sewage works. About 20 tons of refuse collected from a population of about 30,000 is delivered at the works daily. The house refuse, after picking, screening, magnetic separation and pulverizing, is stacked in heaps to a depth of about 4 ft. 6 in., the top surface of the heaps being left saucer-shaped; sludge with a moisture content of about 96 per cent is pumped daily on to the heaps. After four days, the heap is turned over on the concrete floor, then left for another three days. During this period active fermentation takes place, and the temperature rises to about 160° F. The compost is then removed to a maturing heap, here it remains for not less than four months. It is most important to mature the compost; if insufficiently matured compost is added to soil the material continues to immobilize nitrogen, and this action will compete with any plant life and lead to starvation of the crop. Sufficient maturing is only a matter of sufficient time; no additional turning is required. Neglect of this precaution in England has led to quite false ideas about the value of this compost. The price obtained for the fertilizer is from 7*s*. 6*d*. to 10*s*. a ton. The demand is greater than the supply.

The humus heap which has matured for three to four months is almost completely broken down into the condition suitable for addition to the soil. A noticeable feature is the absence of weeds, and particularly of the tomato plants which are common when sludge that has been dried on drying beds is used.

Very large sums of money are spent yearly in the urban areas of England in getting rid separately of two obnoxious waste products, namely, household refuse and sewage, without in most cases getting any return for the money. By mixing them together and passing them through a series of simple processes, not only is nuisance and expense avoided, but also a fertilizer is produced which is vitally needed by agriculture and for which a price can be obtained that should more than repay the cost of its production. The Maidenhead composting works give evidence that there is no serious difficulty in preparing the fertilizer, and it may be anticipated that in future many other towns will appreciate the simplicity and feasibility of the process. In particular it is reasonable to hope that those seaside towns which now turn crude sewage into the sea, fouling the foreshore and making bathing unpleasant and even dangerous to health, will introduce settlement, combined with composting of their refuse, and at the same time make use of the fertilizing value of seaweed. At the present time the need for such a fertilizer is urgent.

CAUSE OF THE NEW HAMPSHIRE EARTHQUAKES OF 1940

L. D. LEET has made an important contribution to this topic by his initiation of a hypothesis concerning the beginnings of the New Hampshire earthquakes of December 20 and 24, 1940, in the Ossipee Mountains district ("Mechanics of Earthquakes where there is no Surface Faulting", by L. Don Leet, *Bull. Seis. Soc. America*, 32, No. 2; April, 1942).

On the basis of the travel-time data on elastic waves from the Ossipee earthquakes, combined with the results of Griggs's experiments on rock deformation and fracture, Prof. Leet proposes the following hypothesis. A zone of radius roughly 20 km. initially unstrained and spherical, extending upward into the crustal layers to near the base of the granitic layer, was progressively distorted by a horizontal shear couple. When the strain reached a critical value for the material, fracture occurred near the original sphere's equator and was the source of the largest shear waves. Distortion by pure shear transformed the original sphere into an ellipsoid, which terminated short of the earth's surface, where fracture had to grade into folding and die out. At the upper terminus of the resultant ellipsoid's major axis, this process would produce a concentrated compressive force on the base of the granitic layer, which started the longitudinal waves. This implies simultaneous mass movement of translation of the upper half of the original sphere. The resultant compressive stresses developed in the granitic layer kicked back four days later and produced the second earthquake. The aftershocks died quickly, in part because of rapid healing of the fractures and in part because the region was brought practically to equilibrium by the second shock, since relief came in zones of flow which, unlike surface faults, have few, if any, irregularities to produce temporary frictional hang-ups as movement progresses. If this is true, the probability is that the Ossipee structure does not extend below the base of the granitic layer, for otherwise a mass movement of the plug, which is an important feature of the White Mountains structure, would have been expected to show up at the surface.

The evidence of recent years is definitely that regional forces are at work on new levels of activity in the north-eastern American province. No great stretch of imagination is required to detect an alignment of some of this activity, including the earthquakes of December 1940, along the trend of the major reservoir for the White Mountains magma series. On grounds of distribution alone, however, there does not seem to be a satisfactory basis for distinguishing between deep-seated magmatic forces in renewed activity and yield to glacial loading stresses along old planes of weakness.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEPUTY ENGINEER AND MANAGER of the Southport and District Water Board—The Clerk to the Southport and District Water Board, Town Hall, Southport (September 14).

FULLY QUALIFIED FOUNDRYMAN to act as SUPERINTENDENT in the College Instructional Foundry—The Registrar, Loughborough College, Loughborough.

FORTHCOMING EVENTS

Friday, September 11

PHYSICAL SOCIETY (COLOUR GROUP), at Imperial College, S.W.7, at 2.30 p.m. Mr. E. G. Savage: "The Teaching of Colour in Schools" (Lecture followed by informal discussion).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Why Hitler? By H. Runham Brown. Pp. 20. (Enfield: War Resisters' International.) 3*d*. [68

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 3, No. 16: Simultaneous Linear Partial Differential Equations of the Second Order. By E. L. Ince. Pp. 195–209. (Edinburgh and London: Oliver and Boyd.) 1*s*. 3*d*. [78

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 2: The Chemical Constituents of Lichens found in Ireland, *Cladonia impexa* Harm. By T. W. Breaden, Dr. J. Keane and Dr. T. J. Nolan. Pp. 5–10. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 6*d*. [178

Geological Map of the British Islands, based on the Work of the Geological Survey. Third edition. Scale of 25 Statute Miles to 1 Inch. 36 in. × 26½ in. (Southampton: Ordnance Survey Office.) Uncoloured, 1*s*.; coloured, 2*s*.; mounted and folded in sections, 4*s*. net. [208

Other Countries

Proceedings of the United States National Museum. Vol. 92, No 3141: Scored Bone Artifacts of the Central Great Plains. By W. R. Wedel and A. T. Hill. Pp. 91–100+plates 7–13. Vol. 92, No. 3143: The Sardis (Georgia) Meteorite. By E. P. Henderson and C. Wythe Cooke. Pp. 141–150. Vol. 92, No. 3144: Rhopocrinus, a New Fossil Inadunate Crinoid Genus. By Edwin Kirk. Pp. 151–155+plates 16. (Washington, D.C.: Government Printing Office.) [317

Publications of the Allegheny Observatory of the University of Pittsburgh. Vol. 8, No. 6: The Field of Epsilon Lyrae. By Esther M. Doody and Keivin Burns. Pp. 77–90. (Pittsburgh, Pa.: University of Pittsburgh Press.) [78

U.S. Department of Agriculture. Technical Bulletin No. 823: Strains of Field Corn Resistant to the Survival of the European Corn Borer. By L. H. Patch, J. R. Holbert and R. T. Everly. Pp. 22. (Washington, D.C.: Government Printing Office.) [78

Smithsonian Institution. War Background Studies, No. 1: Origin of the Far Eastern Civilizations, a Brief Handbook. By Carl Whiting Bishop. (Publication 3681.) Pp. 53+12 plates. (Washington, D.C.: Smithsonian Institution.) [108

Indian Forest Records, New Series. Utilization, Vol. 2, No. 6: The Thermal Conductivity of Indian Timbers, Part 1: Variation of Conductivity with Density in the Air-Dry Condition at Ordinary Temperature. By D. Narayanamurti and V. Ranganathan. Pp. iii+150–167. (Delhi: Manager of Publications.) 9 annas; 10*d*. [118

Indian Central Jute Committee. Technological Research Memoir No. 4: Tests on Commercial Jute Yarns. By C. R. Nodder. Pp. ii+25. (Calcutta: Indian Central Jute Committee.) 1.4 rupees; 2*s*. 3*d*. [128

Annual Return of Statistics relating to Forest Administration in British India for the Year 1939–40. Pp. iii+31. (Delhi: Manager of Publications.) 2.14 rupees; 4*s*. 9*d*. [128

Colony of Mauritius: Department of Agriculture. Twelfth Annual Report of the Sugarcane Research Station, 1941. Pp. 31. (Port Louis: Government Printer.) 40 cents. [138

Some Remarks on Desert Sand-Storms. By F. W. Oliver. (Printed for the Desert Committee under the sanction of the Ministry of Agriculture.) Pp. 16. (Alexandria: Whitehead Morris (Egypt), Ltd.) P.T.2. [138

Report of the Botanical Survey of India for 1940–41. Pp. 188. (Delhi: Manager of Publications.) [138

Records of the Botanical Survey of India. Vol. 6, No. 10: Useful Plants of Mayurbhanj State in Orissa. By S. N. Bal. Pp. xii+119+xx. (Delhi: Manager of Publications.) 4.14 rupees; 7*s*. 9*d*. [138

Forest Bulletin No. 102 (Chemistry, New Series): A Note on the Active Principles of *Embelia robusta*, Roxb., *Myrsine semiserrata*, Wall., and *M. capitellata*, Wall. By S. Krishna and B. S. Varma. Pp. 4. (Delhi: Manager of Publications.) 3 annas; 4*d*. [138

Indian Forest Records, New Series. Entomology, Vol. 7, No. 3: On the Biology of the Noctuidæ (Lepidoptera). By R. N. Mathur. Pp. ii+74–154+1 plate. (Delhi: Manager of Publications.) 2.4 rupees; 3*s*. 9*d*. [138

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 52: Milk Records of Sahiwal Cows in Approved Dairy Farms in India. Vol. 3 (Records received during 1938–40). Compiled by the Animal Husbandry Bureau, Imperial Council of Agricultural Research. Pp. ii+50. (Delhi: Manager of Publications.) 3 rupees; 5*s*. [138

Forest Research Institute. Indian Forest Leaflet No. 18: Some Factors affecting the Quality of Charcoal for Producer Gas Plant. By S. Ramaswami. Pp. ii+6. (Dehra Dun: Forest Research Institute.) 4 annas; 6*d*. [148

Forest Bulletin No. 101 (Chemistry, New Series): Wood Flour for Dry Electric Cells. By S. V. Puntambekar and S. Krishna. Pp. ii+4. (Delhi: Manager of Publications.) 3 annas; 4*d*. [188

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ORGANIZATION OF SCIENCE FOR WAR

NONE of us likes this War, and men of science must especially hate it because they, perhaps more than most groups of professional men, realize how much their work, much of which was carried out with no thought of war, is now involved, and how much the fruits of their labours are often of necessity being prostituted to the immediate aim of destruction. Many of us supported the Herculean attempts which were made to prevent war; but those attempts proved futile, and now science is fighting this War. Nobel died a sad man because he realized how his discoveries were being utilized by mankind. It was, however, his good fortune, after failure in his own lifetime to inspire his fellow-men with the spirit of world citizenship, peace and goodwill, to be able to give to the whole world some means of fighting the persistent and diabolical application of his and other discoveries to warfare. Few men of science could do the same to-day, because science is a calling as well as a profession and not many fortunes are made out of it.

Looking back, however, men of science can justifiably claim that they have fought hard against the utilization of their discoveries for what amounts to the destruction of what science has materially helped to build up. Their greatest mistake was that they did not fight hard enough. They have spent too much time squabbling among themselves over such questions as to what extent science should be planned, if planned at all, and have not sought diligently enough to impress upon the public mind that they realize full well what the implications of their work might be and then act accordingly. Too often have the men of science of the past remained within the four walls of their laboratories, sometimes deliberately closing their eyes to the possible results of their work to humanity once such results have passed into the outer world.

Indeed, some men of science have gone farther than this. Being fully aware of the dangerous policy of letting anyone (probably not so public-spirited as themselves) 'cash in' on the results of their discoveries they have chosen to close their eyes to it in favour of what they claim to be the battle for the so-called freedom of science. Time and time again in these columns have we tried to impress upon men of science that they, above all others, must realize what the impact of their calling is upon society, and, even more important, that they must act accordingly. What has been the result ? Many have agreed with us that it is essential that men of science should be brought to realize much more than they do at present what are the social implications of their work. On the other hand, some have taken the opposite view and have gone so far as to issue warnings that if men of science persist in the so-called planning of their work then they will merely succeed in killing it.

The social, both national and international, relations of science, as indeed of all academic and other disciplines, must be the concern of all thinking men. This should not involve them in political party arguments as some seem to think, for science, if true to herself, cannot recognize party politics any more than she can acknowledge geographical boundaries to the great truths she discovers. The distinction between 'pure' and 'applied' science must go, and a good riddance, for it never was a logical distinction and has been the basis of much futile and wasteful argument. Those men of science who have expressed disapproval of scientific planning visualize, we think, planned science as meaning putting men of science in chains. This could never happen in the democracy for which we are fighting; but even if it did, then surely nothing but good could come of it provided such chains were guiding chains and not prison chains, and always provided that they were under the control of certain men of science themselves—trustworthy men who fully appreciated their duties to their fellow-men and who had the courage of their convictions.

Wars teach us much. This is the first totalitarian war we have experienced, though it took us some valuable time to realize it. By now, most of us have developed shrewd ideas of what we are, or ought to be, fighting for and the paths along which world reconstruction must travel once victory has been achieved. But though we know what we are fighting for and though many of us know what kind of world we wish to see established in the peace to follow, it is very essential to bear in mind one thing here and now; that is, we must win the War first, and we can do that only by fighting—fighting to achieve our immediate war aim, the destruction of Nazism and all for which it stands. One sometimes wonders if the many critics of policy adopted by Government and other authorities always take this into consideration.

With this immediate aim in view, science must be, and is being, planned, not only by men of science but also by those responsible for our war policy, war strategy (offensive and defensive), war production, and so on. It is certain that science is fighting this War the world over. In fact, it *is* a war of science whether we like it or not. We should only succeed in presenting platitudes if we attempted to give examples to illustrate this. Some idea of the views of our American colleagues, in this connexion, can be obtained from an article beginning on p. 310 of this issue.

In view of all this, sad though it may seem from the ethical and even moral points of view, it is actually a matter for congratulation that men of science have not only come forward and offered their services in the war effort, but have also pressed their claims in many quarters and even expressed indignation when their offers have sometimes not been eagerly accepted forthwith. There are, of course, men of science such as physicists, chemists, mathematicians, engineers, and so forth, whose qualifications have meant their immediate absorption into the nation's war effort. On the other hand, some branches of science have felt that they have been left out of it. It was originally the stated function of the Central Register, for example, at one time solely to find men for jobs: But that has now been changed, and if certain men of science have been able to prove their worth, jobs have been found for them. There are, however, even now, some scientific workers, especially among the biologists, whose positions might profitably be reviewed.

Furthermore, there is a tendency for individual, and groups of, men of science at times to urge the importance of this and that problem and press for an immediate inquiry, thus leaving the implication that those in authority are unaware of such problems and are therefore doing nothing about it. But this is not always the case. Though it is true that Government departments have at times betrayed a lack of awareness of what problems exist and what ought to be done, some men of science and even groups and associations have shown a lack of knowledge of what is already being done or, at any rate, a lack of sympathy with all the problems which might conceivably be involved. Of the many suggestions put out for the consideration of Government ministers and departments some show a definite lack of knowledge of what that minister or department is already doing. In this way, through not making certain of what has already been, or is being, done and not maintaining a sense of values, such men of science often defeat their own ends.

But in spite of all this, some men of science have been quite justified in claiming that their services are not being utilized as they should be, and many more have expressed concern over the failure of the Government to co-ordinate the scientific effort more efficiently. Of course, no Government can be expected to know all that science has to offer; hence a certain justification for the grouses and grumbles of some sections of the scientific community. On the other hand, men of science must not assume that just because the plans of the Government and its various ministries and departments are not going along the lines which they, individually or collectively, think are the right ones, the Government is therefore closing its eyes to the golden opportunities which science has to offer. A very keen sense of values is necessary, and above all co-ordination and organization within, and between, the scientific and other aspects of our war strategy are essential.

Yet the Government has never been above criticism where the utilization of science in the war effort is concerned, and some of its faults have proved to be serious ones. For this reason we welcome the announcement made on September 4 that

"In order to ensure that the fullest use is made of our scientific and technical resources in the field of production, the Minister of Production has appointed Mr. W. A. Stanier (Chief Mechanical Engineer to the London, Midland and Scottish Railway), Dr. T. R. Merton (Treasurer of the Royal Society), and Dr. I. M. Heilbron (Professor of Organic Chemistry, Imperial College of Science and Technology) to his staff in the capacity of full-time Scientific Advisers."

As a mechanical engineer, Mr. Stanier is well known. He was president of the Institution of Mechanical Engineers last year and is at present chairman of the Railway Executive Committee's Mechanical and Engineering Committee. Mr. Merton was formerly professor of spectroscopy in the University of Oxford, and his work carried out in the

University and in his private laboratory since has brought him an enviable reputation. Prof. Heilbron is professor of organic chemistry in the University of London (Imperial College of Science and Technology). His work has shown him to be interested in biological as well as chemical problems. Also, few chemists have had wider experience in connexion with the chemical industry than he. He has acted as scientific adviser in various capacities to the Ministry of Supply since the War began.

The official statement, in announcing these appointments, continues:

"The field of activity of these advisers will be co-extensive with the responsibility of the Minister of Production. They will keep in close touch with the scientific advisers of the Service and Supply Departments, and will be available to assist the departmental organizations of scientific research and technical development. They will not supersede the departmental organizations, which will, for instance, continue to be responsible for the examination of new inventions and technical suggestions in their own fields.

"They will be responsible to the Minister of Production, but will work under the immediate supervision of the Lord Privy Seal, acting on his behalf.

"These appointments have been made with a view to completing the existing organization for scientific research and development which has been carefully built up over a number of years and operated with outstanding efficiency.

"The Government have reviewed the whole position in the light of recent representations, and have decided that the creation of the post of Minister of Production affords the opportunity for this further measure of co-ordination which the Government believe will be to the national advantage."

To say the least of this announcement, it is an excellent example of democratic government, and those who have made representations to the Government recently can be assured that their efforts have not proved altogether sterile. Science has again raised its voice, and again that voice has been heard. The response of the Government will give considerable satisfaction. Our immediate aim is, of course, to criticize; but there is not a great deal to criticize. However, the statement that "These appointments have been made with a view to completing the existing organization for scientific research and development which has been carefully built up over a number of years and operated with outstanding efficiency" is, we think, a very bold one. Much scientific research has certainly been carried out along highly efficient lines, but it is doubtful if this can be said of all projects of research. Furthermore, even if all scientific research were carried out efficiently this does not necessarily spell satisfaction to the State, for it has to be organized and brought into line with the immediate needs of the country at war. Whether this has been done "over a number of years and operated with outstanding efficiency" and therefore, presumably, to the satisfaction of the majority, is questionable.

Furthermore, while it would be a pity to have any group of scientific advisers too large, this one possibly errs on the other side. We feel that at least five men of science should have been appointed, though we are doubtless safe in assuming that those who have been appointed will always know where to go for help and advice on any problem which might arise and which does not come within their own province. After all, in such a united country as this, so far as the war effort is concerned, the whole field of science is open to them. All three men are well known in the scientific world and therefore they themselves must know their scientific colleagues or their work.

It may be as well to note here that all three men are scientists. NATURE has never recognized any distinction between men of science and engineers; the latter are a class of the former. The tendency in some quarters to make an unnecessary distinction is confusing and sometimes leads to friction.

Some men of science, often eloquent in their criticisms and strong in their attacks, seem to fail to realize that scientific qualifications are not enough. Some scientific workers do not show the aptitude necessary for the type of work which Government departments might be demanding. Scientific achievement and aptitude must be considered hand-in-hand, and the newly appointed men will be the ones to do this, for they will know exactly where to go for the necessary information. Furthermore, we have little doubt that the men appointed will bring together a panel of advisers, individual or in groups (though not necessarily on paper), to whom they can turn for assistance whenever an occasion demands. Such a panel should remain a very plastic one, for no one, not even men of science themselves, can visualize exactly what problems will arise as the War proceeds.

That the newly appointed full-time scientific advisers will be under the supervision of the Lord Privy Seal, Sir Stafford Cripps, will also give considerable satisfaction, especially among men of science. As an officer of the State, Sir Stafford has already proved himself a public-spirited, keen, unselfish and efficient worker; but many will not know how fully he appreciates the value of science to society to-day, and above all to the war effort. Sir Stafford began his career as a scientific worker and carried out some useful research work under Ramsay several decades ago*. He has always since retained his interest in science.

Through Sir Stafford Cripps's keen appreciation of the work of men of science, and through his senior position in the Government, men of science should, via the new scientific advisers, be able to establish a more direct contact with the heads of the Fighting Services, the Air Ministry, War Office, Admiralty, Civil Defence authorities, and such Ministries as those of Fuel, Transport, Food and Supply, than has hitherto been possible. Thus men of science will not only be able the sooner to grapple with problems posed to them, but, just as important, their own suggestions and ideas might well receive a more sympathetic hearing. Through Sir Stafford and his advisers science will be able to place its help and advice in the quarters where it is urgently needed without having to waste valuable time explaining its implications and importance.

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* "The Critical Constants and Orthobaric Densities of Xenon", H. S. Patterson, R. Stafford Cripps and R. Whytlaw-Gray (*Proc. Roy. Soc.*, A, 86, 579; 1912).

The scientific point of view is an important one in modern war policy and strategy, but not all non-scientific men have it. In fact, some of them, including certain ones in authority, have demonstrated impatience with, or ignorance of, science; but this cannot be said of Sir Stafford Cripps. It is known by many that he is very keen that science should take its rightful place in the forefront of the war effort.

This Government announcement is, therefore, one of the most encouraging that have been made during the War. It should now be less difficult to ensure that scientific and technical advice of the highest calibre be forthcoming when and where it is most urgently required. Men of science never willed or wished for this War any more than the rest; but, since it is inevitable, then men of science wish to play their part to the fullest of their capacity in helping to win it. Above all, they naturally want to be sure that their efforts are being appreciated and utilized to the utmost. Doubts concerning this have frequently been justified, for Government circles are not the only ones who should be aware of the importance and potentialities of science. The lay public should be more familiar with the scientific war effort. As it is, the layman seldom learns anything unless it is sensational or until something goes wrong. Even this announcement, important though it is, received only a bare mention on the radio and was not noted at all, or only casually mentioned in such a way as to tell the reader practically nothing, in the more popular newspapers.

Even at this stage, therefore, and taking a very long-distance and comprehensive view, it seems that the tail is wagging the dog. But the need is urgent, and at any rate something has been set in motion. If science were taught in our schools as a social study rather than as it is—a vocational exercise of little use to the majority of students—then the public as well as authoritative appreciation of the value of science to man during peace as well as war would become axiomatic and men of science would not have to put up the strong fights which are at times necessary, as things are.

Absorption of these three outstanding men of science into the higher grades of the war directorate has shown that those in authority have once more recognized the indebtedness of the country to science as a means of fighting and winning the War. Especially is this so in that science will be more able now to help to further the interrelationship of production with strategy. It is a good beginning in the right direction; but it is only a beginning. These men of science will have as their main task the co-ordination of all scientific work, and no doubt they will see that any scientific workers who might prove useful but have hitherto been overlooked will henceforth be used in the common effort. It is scarcely likely, however, at this stage of the War, that many men whose qualifications are of the first class and of direct value to the country at war are still not in harness. We have repeatedly claimed, however, that the men of science in the various Service Departments and the many other Ministries and Departments which need the aid of science should have easier access to their scientific counterparts outside, and vice versa. Though the new advisers will not wish to be inundated and hampered at the outset with unsolicited suggestions, they will now have a splendid opportunity for bridging this gap which has been all too prominent in the past. They will now be able to see to it that no loophole is overlooked, no claim ignored or discarded before having been thoroughly examined by those qualified to judge, and, by co-ordinating and periodically reviewing the scientific work of the country, that no wasteful overlapping of effort goes on unquestioned.

Some of us would have preferred that the scientific advisers now appointed, especially since their new duties will occupy their full time, were entirely free from any departmental organization such as the Ministry of Production. Further criticism in this connexion has been made by the Parliamentary and Scientific Committee (see p. 316). But this is happily offset by the statement that they "will keep in close touch with the scientific advisers of the Services and Supply Departments and will be available to assist the departmental organization of scientific research and technical development". Furthermore, the supervision of the Lord Privy Seal should do much to prevent their work being canalized too much. The work of these men will be prodigious, but of the utmost importance. The men themselves are doubtless equal to the job, but the extent of their success will depend in no mean degree upon the way in which the non-scientific authorities react to, and collaborate with, them. The same scientific spirit must permeate the whole organization of production and strategy.

At present, we are fighting as one of the United Nations to destroy the hideous forces at work in many parts of the world seeking to impose their will on all peoples. This is, and must remain, our immediate aim until such evil forces are eliminated and certain victory is achieved. To do all this in the minimum of time and with the maximum of effort, much of our peace-time science has to be shelved, and the rest organized and planned. Surely then an analogous form of planning will be necessary in the great fight which will follow the armistice—the fight to establish a world based on the democratic principles expressed in the Atlantic Charter and reiterated often enough since its announcement a year ago. As emphasized by President Roosevelt recently (see p. 316 of this issue), victory is essential but not enough; we must ensure the 'four freedoms' for generations to come, and it will require bold vision, intelligent planning and hard work.

In all the announcements made since that time, perhaps freedom of conscience looms up as the most important, for, as Thomas Mann recently said, a general work of spiritual restoration will have one of the first calls after the War; but next to this is surely freedom from want, for it will be useless to preach this or that principle, or to tell of the necessity for collaboration by subjugating selfish ends, to a people who is starving and shivering and in constant dread of extermination through lack of the simple necessities of life. Freedom from want is therefore the most comprehensive of all the freedoms, and as Sir John Orr has so aptly pointed out, this freedom must be among those first things which will have to come first.

In this fight for establishing freedom from want, science will have to play a very important part. In fact, its aid is now being invoked in the preparations already being made for dealing with the acute problems for which we shall have to be ready immediately hostilities have ended. To do all this efficiently and quickly, science must be properly planned and organized so that it can play its part efficiently and not along those haphazard lines which have so frequently been characteristic of it in the past. This is one of the conceptions which the War has forced upon us. While we must never condemn any piece of scientific work because we cannot attach any immediate utilitarian value to it, at the same time men of science must recognize their duties to society and thus be willing to be properly organized so that they give the maximum of service to the community, to the State and to the world. Sir Stafford Cripps and his newly appointed scientific advisers form an excellent example of what can be done in war-time. Let us hope that the lesson will not be forgotten in the peace to follow. Here we have science organizing itself with the help, but not the coercion, of the State.

ORGANIZATION OF POST-WAR RELIEF IN EUROPE

AN admirable report of a Study Group of the Royal Institute of International Affairs entitled "Relief and Reconstruction in Europe: the First Steps", outlining and relating to one another some of the immediate practical problems which will confront Europe when the War ends, makes its appearance when leading American statesmen have indicated their firm support of the broad policy laid down by Mr. Winston Churchill in his declaration of August 20, 1940, in connexion with the sending of relief to Europe. The report is a preliminary survey of the specific problems, of a general as well as a technical nature, which are involved in that policy. The studies on which the report is based are limited to Britain's policy towards Europe.

Mr. Churchill's declaration was followed by the declarations of the Allied Governments at a meeting at St. James's Palace on September 24, 1941: that it was their common aim to secure that supplies of food, raw materials and articles of prime necessity should be made available for the post-war needs of the countries liberated from Nazi oppression, and that while each of the Allied Governments and authorities would be primarily responsible for making provision for the economic needs of its own peoples, their respective plans should be co-ordinated for the successful achievement of the common aim. This aim of social security abroad no less than at home has been affirmed repeatedly by Mr. Eden as an objective of British foreign policy, and in his speech at Nottingham on July 23 he pointed out that the first task would be to feed the starving populations. There was also, he said, the problem of enabling devastated, impoverished and economically undeveloped countries to restart their agriculture and industry. Here two principles should govern the relations between such countries and those more highly developed: receipt of financial and economic aid must not result in any loss of independence for any country; and any form of assistance or guidance given to a country unpractised in the art of self-government must be such as to help it to achieve its own development.

The recent Washington Conference led to a scheme for ensuring that large supplies of food will be available for distribution when the time comes, and since the establishment of the bureau for collaborating in framing estimates of requirements of foodstuffs, raw materials and articles of prime necessity agreed upon at the Inter-Allied meeting on September 24, 1941, Russia has entered the Allied Councils. Obviously, her representatives will be specially fitted to give guidance on relief problems in eastern Europe. Moreover, the United Nations will also be able to call on the help of such surviving machinery of the League of Nations as the Economic and Financial Sections and of the International Labour Organisation.

Neither relief nor reconstruction, the report points out, can be carried out in a state of anarchy. The most urgent task of all, the transportation and distribution of food, depends on the existence of a minimum of order, and while in some countries the objects of the Allies will be achieved in association with a Government which enjoys their confidence and co-operation, in others their association with what purports to be the governing authority will require careful thought. Moreover, publicity as well as policy will be important and should be the subject of Allied consultations. The execution of measures of relief will require the constant use of publicity to give information and instruction to the people concerned. Allied control of broadcasting and news services and propaganda organs will be necessary in countries under military occupation, or through which Allied lines of communication pass, first as a direct military measure, secondly to prevent propaganda likely to frustrate the execution of Allied policy; and thirdly, to foster in ex-enemy countries such constructive and co-operative tendencies as exist.

This problem of authority and order is discussed in considerable detail with reference to Germany, where the difficulties are likely to be greatest. The analysis is on lines similar to that of a Planning (PEP) broadsheet issued last year, but stress is laid on the necessity that nothing should be done or permitted which conflicts with the cardinal aim of effectively dissolving German armed power. While the situation in Germany at the end of the War may well be one of chaos, tempered more or less by force of bureaucratic habit, the actual task of control may not be so difficult as it seems. A far-reaching military occupation will undoubtedly be necessary, and apart from disarmament, which must begin at once, the Allies must be prepared to accept heavy administrative, military and economic burdens if the opportunity of making Europe secure is not again to be thrown away.

If effective immediate help is to be given, plans for action in the economic, social and technical fields must be drawn up in advance, so that they may be put into operation simultaneously with measures for restoring order and authority. Last-minute improvisation, though in some respects unavoidable, may lead to confusion. Similarly, it is true that, in view of the uncertainty of the future, the plans drawn up must be flexible and will require revision from time to time.

The main task will be to organize food relief and health measures, and the report urges that the only hope of achieving rough justice in the allotment of priorities would be to regard Europe, or those parts of Europe to which we have access, so far as possible as a whole from the beginning. This will demand an important moral and intellectual effort of the more favoured peoples, and particularly cognition by the politically effective groups that a community of interests between the European peoples exists and demands this first instalment of practice. In point of urgency of need, no real distinction will be possible between the supplies required to meet immediate human wants, such as food, clothing and medicaments, and supplies of seeds, fertilizers and certain kinds of raw materials. An adequate relief policy must provide both; but whatever can be done beforehand to settle the major aims of policy will increase the chance of effective immediate action.

The report recalls, in sufficient detail to enforce this point of the necessity of planning relief in advance, the handling by the Allies of the re-victualling of Germany after the War of 1914–18. While the financial and political conditions on which Germany should receive relief in accordance with the estimate of her needs should be determined beforehand so far as possible, the character of the immediate measures will be determined also by the views which may be formed on the economic future of Europe, and on the institutional framework which it is desirable to establish. It is already widely recognized that both national and international organizations will be required, and the report elaborates the steps by which there might be developed a Reconstruction and Supply Authority, with wide powers and a flexible organization, from the Inter-Allied Bureau and Committee to which reference was made at the Inter-Allied meeting on September 24, 1941. This Authority, working with and through the local authorities, whether national governments or other serviceable elements, should be capable of mobilizing the resources of technical knowledge, co-operative will and administrative capacity wherever they are found. Its activities will of course require co-ordination with those of the Armistice Commission or other inter-Allied authority responsible for the re-establishment of order and the disarmament of enemy States.

The experience of 1918 emphasizes the importance of a clear understanding on the vital matter of organization well in advance, and whatever use may be made of existing machinery, its efficacy in action will largely depend on careful planning, the first general object of which is to form, and constantly revise, an estimate of the actual changing situation in Europe and what is needed to meet it; the condition and probable needs of agriculture; the state of transport, both ocean-going and internal; the state of health, particularly with respect to deficiency diseases and the risk of epidemics; refugees, transferred labour and other movements of population; financial position; raw materials and plant necessary to restore peace-time production; administrative personnel likely to be available—all these will require estimates. Much guesswork will obviously be inevitable, but it should be reduced to a minimum.

It is probable that fairly accurate provisional requirement programmes could be prepared for most countries by the Bureau, and estimates made of the supplies likely to be available to meet them. Such programmes should be prepared, where practicable, on the basis of regions dependent on particular ports, so that all shipments to the same region may be bulked, thus enabling account to be taken of local supplies and allowing the use of local surpluses for distribution in that region. In estimating requirements, use should be made of recent scientific work on standard diets, and to meet the urgent demand for supplies, large stocks must when possible be held in readiness. A beginning has already been made with the establishment of a Ministerial Committee on Export Surpluses. Flexibility will be essential if the best use is to be made of the available supplies and shipping.

From food and supplies the report turns to the question of health, and against the gloomy picture of widespread epidemics and an increase of disease generally, especially those directly or indirectly connected with malnutrition, it sets the various organizations which will be available to aid the national health services. On this point of organization it is emphasized that, while relief work under the direct control and supervision of the body providing relief is the easier and may be necessary in the initial stages, it is essential to operate as soon as possible only through the Government concerned and by utilizing that Government's machinery. Secondly, the control of starvation and such diseases as may be expected after the War depends primarily on transport, economic reconstruction and agricultural recovery, and only secondarily on medical personnel and drugs. Any medical relief organization should be closely linked from its inception with these three branches of relief work.

The report makes the third point that medical relief work must be regarded as part of the work of a future international body and should become part of this organization as soon as it is created. It is suggested that on the conclusion of hostilities, use should be made of the Health Organisation of the League of Nations which, with greatly reduced personnel, still operates in Geneva. From some points of view this would be a rapid and efficient solution of many of the urgent medical problems that will at once arise. Apart from this question of deciding what type of central co-ordinating organization is to be used for urgent medical relief work, the immediate tasks are to encourage among the voluntary organizations action designed to co-ordinate post-war relief measures and to examine the possibility of building up supplies of medical relief stores.

In regard to transport, the importance of relief convoys and personnel being able to move freely across frontiers without being held up unnecessarily by Customs and other formalities is urged. Such measures as a waiving of national road transport licensing systems and the removal of other obstacles to through transport of all kinds are desirable. Much greater co-ordination will be required among air communications, which should gradually pass into civilian hands as soon as possible. In regard to movements of population, disorderly dispersal, whether in camps or in large industrial undertakings, should be prevented by military or other Allied officials on the spot with power to provide for immediate needs and instructions for the workers to remain where they are until proper arrangements for their transfer can be made. Alternatively, instructions should be given in advance, if possible, to trade union or other leaders through their national Governments or their trade union organizations.

The relief and reconstruction problem is a supply problem, and financial considerations in the narrower sense will play only a secondary part. Broadly speaking, those providing the supplies will in the first instance have to take the responsibility. A positive supply policy based on priorities in relation to needs will be required ; even major financial questions should not be allowed to cause delay. The report indicates briefly a number of the measures which will be required, such as limitations on personal expenditure by rationing, canalization of investment and control of the capital market. There will be no orderly procedure by which Europe, having subsisted on outside relief for a brief period of convalescence, will then set itself to reconstruct its peace-time economy. The two processes will be simultaneous and inextricable, though later, one will absorb the other. In regard to agriculture, the Reconstruction and Supply Authority could probably perform a valuable service by providing technical advice, but to form an adequate estimate of the requirements of industry even for the immediate post-war period will demand a clear view of long-term economic policy. What is important is that the study of these questions should be undertaken at the earliest possible moment. Meanwhile, the evolution of the actual situation in Europe should be closely followed, and as long-term policy becomes more clearly defined, at least provisional opinions should be formed as to which tendencies should be reversed and which maintained, so far as the decision rests in Allied hands.

The urgency of planning for post-war reconstruction is demonstrated quite as conclusively in a further monograph, also issued by the Royal Institute of International Affairs, under the title "Medical Relief in Europe : Questions for Immediate Study", in which Dr. Melville D. Mackenzie gives an excellent though brief outline of some of the medical consequences of war and of the measures which a medical relief organization must be equipped to apply. Starting with a review of the factors, such as movements of populations, agricultural breakdown, transport difficulties and general economic strain on the population, impairment of public health and hospital services, which contribute to post-war medical problems, Dr. Mackenzie draws effectively on the experiences of relief work in 1919 and the following years to emphasize the need for a central medical authority covering the whole of Europe and prepared to go into action as soon as hostilities cease. On this question of organization he reiterates the arguments advanced in the report already quoted, but goes into further detail as to the problems which could be dealt with by a Medical Committee before the end of hostilities. This will include the collection and pooling of reports on medico-social conditions in Europe, the reconstruction of medical services, equipment and stores, the determination of standard rations, and the study of the medical needs of special groups.

Dr. Mackenzie then proceeds to discuss in some detail the special problems which may be expected to arise from malnutrition, typhus fever and malaria, and the preparation which might be made to deal with the situation. There follow admirably argued concise chapters on the necessity for the resumption of international health work in the light of the results achieved during the last twenty years, and on considerations relating to the re-establishment of a permanent international medical organization. These alone are of interest to every scientific worker, and they fully substantiate the conclusion that the urgent medical problems which will require solution the moment hostilities cease can already be discerned so clearly as to make immediate action both possible and essential.

It is true that the form of permanent constructive work in the sphere of international medicine depends so much on political, economic and social developments in the post-war period that any attempt to envisage it on more than the broadest lines is premature. Much, however, can clearly be learned from difficulties encountered, successfully or unsuccessfully, in the past ; and it is equally clear that only through international collaboration can the fullest use be made of our neighbours' and our own knowledge in the control of ill-health throughout the world. Solely by such co-operation can research be co-ordinated to avoid waste of effort, the spread of epidemics checked, and clinical and administrative knowledge pooled for the benefit of all. The nature of the most effective permanent machinery, how and when it can be created, and the exact tasks it should undertake, are questions linked with the future welfare of every community. Even in the present crises, they cannot fail to engage the deep thought of men of vision in every community.

These two publications of the Royal Institute of International Affairs are a sufficient answer to those who would defer consideration of planning for post-war reconstruction, either on the ground that attention must not be diverted from more urgent tasks or that the situation which such plans must meet is still unpredictable.

DEDUCTIVE COSMOLOGY

Time and the Universere

A New Basis for Cosmology. By Dr. F. L. Arnot. Pp. 76. (Sydney: Australasian Medical Publishing Co., Ltd., 1941.) n.p.

IN recent years it has been suggested that the laws of Nature can be reached by deductive methods instead of by inductions from observation. We may, with Eddington, assert that the chain of deduction starts from epistemological premises or, with E. A. Milne, that it begins with axiomatic statements defining the character of the system to be studied. Opinions differ widely regarding the value of the deductive method. If it is to be adopted, however, we may well ask that the author of a deductive theory should fulfil the following requirements. First, he must himself be aware of all the axioms or premises which he employs. If he is not, there can be no guarantee that inductive premises have not unwittingly been incorporated into the theory. Secondly, the axioms should be clearly recognized for what they are. They should not be introduced piecemeal in the course of the argument under the guise of deductions from the theory previously developed. In this respect, the model is Euclidean geometry, which begins with a statement of all the definitions and axioms that are afterwards used. Thirdly, the theory must be self-consistent and, naturally, free from mathematical mistakes. Under this heading we may also ask that consequences deduced from the theory should either be capable of check by observation or, if this is impossible, that they should at least be plausible.

We may attempt an analysis of Dr. Arnot's cosmological theory in the light of these principles, since it is of the deductive type. The author claims that his theory is based on two axioms only. First comes the axiom stating that there are two scales of time, a t-scale and a τ-scale, related by Milne's formula

$$\tau = t_0 \log(t/t_0) + t_0, \quad . \quad . \quad . \quad . \quad (1)$$

where t_0 is the present moment on the t-scale. The τ-scale is, by hypothesis, used in mechanics and physics generally. The t-scale is a scale which gives a finite age for the universe. The second axiom is the principle of the conservation of the energy of the universe as a whole.

It is impossible in a short review to deal with all the points raised by Dr. Arnot's theory. It will be sufficient to consider his three fundamental results in turn. His first result is that the velocity of light is constant on the τ-scale (c_0) and on the t-scale is c, where

$$c = c_0\, t_0/t, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and is therefore variable. The two axioms stated above do not however give the result: a third is introduced, apparently unwittingly, namely, that the measurement of distance is independent of the time-scale. This is contrary to the principle of special relativity, where transformations from one time-variable to another are not independent of spatial transformations. Yet at a later stage in the theory Dr. Arnot sees no inconsistency in using results deduced from the Lorentz transformation in his theory. However, it might be possible to prove that the transformation (1) does not imply spatial transformation. The red-shift of the spectral lines of nebulæ at *fixed* distances apart is deduced from (2). But not without the introduction of another axiom (on p. 34), this time presented as if it were a deduction from the foregoing part of the theory. This axiom states that the emission frequency of a photon is independent of the time of emission t. The reader cannot but feel that *ad hoc* assumptions are being made in order to account for the red-shift without appealing to the idea of velocity.

Dr. Arnot's next result is that the number of particles in the universe varies as t^2 if the t-scale is used and is constant if the τ-scale is used. This follows from the principle of the conservation of energy for the universe as a whole, from the result (2) and from another additional axiom, namely, that the mass of the electron is the same on the t-scale and the τ-scale. No satisfactory explanation is given of why a change of *time-scale*, which is equivalent to directing one's attention from one clock to another working at a different rate, should alter this *number*. Moreover, it is necessary to suppose that, when the t-scale is used, particles are being created as t increases, but that this creation ceases as soon as an observer chooses to use the τ-scale. The correct conclusions at this stage would seem to be that the axioms so far used lead to a result which is not only incapable of observational check but is also in itself incredible, and that another set of axioms should be tried.

The last result which lies at the basis of the theory is a value (ct) for the radius of the Einstein universe. This is obtained by a mathematical fallacy which consists in confusing the "radius" of 3-dimensional spherical space with the radius of a spherical volume in Euclidean 3-dimensional space.

In justice to Dr. Arnot, it must be said that his book is a posthumous work. Had he lived, he would no doubt have noticed the inconsistencies and gaps in the argument which exist in the work as it stands, and he would have corrected them. As it is, his book serves to point the moral that the way of a constructor of deductive cosmologies is very hard, and is beset by pitfalls into which he may plunge without being aware of doing so.

G. C. McVittie.

INTRODUCTION TO ATOMIC PHYSICS

Introduction to Atomic Physics

By Dr. S. Tolansky. Pp. xii+343+5 plates. (London, New York and Toronto: Longmans, Green and Co. Ltd., 1942.) 15*s*. net.

THE purpose of this text-book is clearly defined in the foreword by Sir Lawrence Bragg. It follows from the belief that a student should be introduced to the great basic advances in experimental and theoretical physics in recent years in his second rather than his final year of undergraduate study. The contents of the book are then intended to form a background to the next year of more intensive treatment.

Many teachers will sympathize with this view, but will also appreciate the difficulties which confront an author when he sets about his task. There are difficulties of choice in such an enormous field of material, of decision as to the depth of treatment, and whether, if superficial or highly condensed, it can be of material benefit to a student at this stage. How far he has succeeded in arriving at a satisfactory solution of these problems may be a matter of opinion. At least it has appeared in print during a quiescent period of publication of new results in this field, when there is little danger of data becoming out of date while the book is in press.

Much of the contents will be of value to the student at this stage. The book has nineteen chapters, and, in addition to stock material which every such text-book must include, there are chapters on the quantum theory, the structure of crystals, the wave mechanics, cosmic radiation and the positron and meson, and relativity.

The two chapters on gaseous conduction and discharge, compared with other text-books, are considerably abbreviated. This is reasonable provided that the student is not led to think that a given subject is quite cleaned up when in fact it is still in a confused state. The paragraphs on recombination are somewhat misleading in this respect. Also the original method of deriving an equation for sparking potential due to Townsend is given. But it is now generally held that ionization by positive ions in weak fields is very improbable and that secondary emission from the cathode must be invoked instead to explain the maintenance of discharge. An equation agreeing equally well with experiment can be derived on these lines.

In Chapter 3 the introduction of a recent precision method of determining e/m is welcome, as well as the summary of measurements of Avagadro's constant. Similarly, the chapter on positive rays is good, though Fig. vii referred to in the text is not included in the plate.

In a short chapter on the quantum theory, proofs are given of Planck's equation, Debye's expression for specific heats, as well as the Bohr hydrogen atom. Since the book is based on experience of lectures on these lines in Manchester, one must conclude that this abbreviated treatment of black-body radiation and specific heats has been found to be successful. I myself would have been content with a more descriptive summary at this stage with emphasis on experimental results, leaving the full theoretical treatment for one bite in the following year. But this is merely an individual view, and the volume loses no interest through provoking this type of comment.

In Chapter 6, on the thermionic effect, one welcomes a descriptive reference to the modern theory of electronic states in solids. It is right and proper that students should realize that these concepts can be applied to metals and insulators, with which they are so familiar in the laboratory, as well as to atoms. But students may be puzzled by the integral on p. 110 as the text is worded. It is also questionable whether the 'shot' effect could ever give a precision value of electronic charge. The experimental values so far obtained show wide divergences. In the chapter on atomic spectra the author can speak with special authority. The student will find it tough going and is called upon to accept a number of statements without proof. But with the exception of the Zeeman effect, to which surprisingly scant reference is made, the meat is all there for the good student prepared to dig into it.

The chapters on X-rays and the structure of crystals contains much useful information, and in the next chapter student readers are introduced to the difficult subject of wave mechanics. It is to be hoped that they will complete the chapter still imbued with humility, and not be tempted to talk glibly about it. But the statement of the conditions under which Schrödinger's equation can be solved (p. 199) requires correction.

The greater part of the remainder of the book is taken up with radioactivity and the nucleus. The material is up to date and well selected, and students will read it with interest, not only because so much of it is experimental in background and therefore not difficult to grasp at this stage in their mathematical training, but also exciting. Having got them into this atmosphere, the author pulls them up sharply by a concluding chapter on relativity.

In brief, the selection of material is interesting and in many respects novel. But the book shows signs of hurried writing. There are a number of errata which have not caught the eye of the proof readers, and should have been added to the list on p. 1. Here and there the text is also rather loose. But the task of writing it under the pressure of present conditions calls for some allowance in such matters, and one may anticipate a new edition at an early date with emendations. A. M. TYNDALL.

ADVANCES IN MEDICINE

The March of Medicine

(New York Academy of Medicine: Lectures to the Laity, No. 6, 1941.) Pp. xiv+154. (New York: Columbia University Press; London: Oxford University Press, 1941.) 13*s*. 6*d*. net.

THIS volume contains six lectures devoted respectively to: humanism and science, by Dr. Alan Gregg, director for the medical sciences, Rockefeller Foundation; Paracelsus in the light of four hundred years, by Dr. Henry E. Sigerist, director of the Institute of History of Medicine, Johns Hopkins University; psychiatry and the normal life, by Dr. William Healy, director of the Judge Baker Guidance Centre, Boston; philosophy as therapy, by Dr. Irwin Edman, professor of philosophy, Columbia University; the promise of endocrinology, by Dr. Oscar Riddle, Department of Genetics, Carnegie Institution of Washington; and "What we know about Cancer", by Dr. Francis Carter Wood, director of the Laboratories, St. Luke's Hospital, New York City.

Dr. Gregg maintains that humanism offers much to science and especially medical science on the occasions when the physician finds science inadequate for the patient's needs and should call in the help of literature and the arts. Dr. Sigerist declares that while Paracelsus's contributions to medicine were of a totally different kind from those of the other great physicians and surgeons of the Renaissance, he made a number of valuable contributions to medicine, particularly as regards treatment, into which he introduced many chemical remedies. According to Dr. Healy, the time is ripe for psychiatry to take a lead in educating the normal man to know more about himself "for the sake of his own self-direction in social interrelationships". Dr. Edman, while not asserting that philosophy is a substitute for medicine, logic for surgery, or ethics for antiseptics, declares that philosophy is therapeutic in the sense that it is both sedative and stimulant, while the good physician is a kind of family and social philosopher. Dr. Riddle foretells that in the future endocrinology will add to human efficiency, normality, understanding and health. In conclusion, Dr. Wood shows that an enormous advance has been made in the treatment of cancer, especially in early cases, owing to the technical developments of surgery and the discovery of the destructive effects of radium and X-rays upon malignant tissue.

SCIENCE IN PEACE AND WAR*

By WATSON DAVIS,
Director of Science Service, Washington, D.C.

IN every sense this is a scientific war. On the fighting fronts, precisely built machines of defence destruction are manned by men expertly trained and laboriously supplied. On the home fronts production, transport and world economic strategy are the prime concern. Backing up this gigantic war effort are knowledge, thought, planning and research. Of particular importance is the scientific research, not just of to-day but of past years.

Unfortunately, the layman is usually oblivious to the scientific basis of our civilization until something goes wrong. To people without the vision and power that experiment and interpretation of experiment bring, the universe is a static, unchanging, finished creation which, nevertheless, rushes on and leaves them hopelessly behind. That is what has happened and will happen to individuals or nations without the precious ferment of scientific research. All tradition, lore, or musty mores are hopeless before the onslaught of new ideas, whether those ideas project a panzer attack or give a new mode of peaceful living to the world.

The scientific method in one sense is completely divorced from social consequences. Men of bad will can, with unenviable cunning, use the priceless, time-tested, experimental method to fashion offensive weapons which can be used to annihilate the environment and the people from whom true science must bring the continuing progress of the world. The metallurgist who makes possible a fine, keen butcher knife of stainless steel, a useful product of his technology, can of himself do little to prevent the use of that knife for murder by a mad butcher.

In another sense, the utilization of the resources of the world, including the knowledge and methods and mechanisms produced by science, is a real concern to those who are scientifically creative. It would be logical and not too much to expect that men of science take more than a democratically average interest in preventing destruction and aggression, misappropriation of our material resources, the distribution of good things of this earth among all the peoples, and the assurance of that essential minimum of food, clothing, shelter, education and freedom to all. This means that men of science and engineers must be more than creative specialists; they must be leaders in living and social organization, within the limits of their abilities.

Science can greet with equanimity the unreasoned criticisms that sometimes come to it, stating that science has created new and more deadly weapons. Of course it has. It has created mechanisms and devices for offence, as well as defence, just as it has brought into being many new homely, peaceful things of life. From the earliest days of war, even before lance, sword, and bow-and-arrow gave way to the chemistry of gunpowder, the major developments of war were the creation of science. Smokeless powder, the rifle, artillery, the submarine, high explosives, the aeroplane, armour, poison gas: all of these are from science's armoury.

There should be no undue surprise if and when novel and unconventional weapons come to light in this War. Added to the devices of previous conflicts, we have in this great world-enveloping struggle, weapons and devices new either in themselves or in their application. First among these perhaps is the aeroplane, with its revolution of strategy and tactics. We see in the modern war plane the result of aerodynamical research and developments in metallurgy and petroleum chemistry.

We know that there are radio devices which reach many miles out to sea to detect aeroplanes and ships, devices which may very well usher in a new era of radio application once peace releases them from their essential war work. We know that rockets in various forms are finding fighting applications, and we can guess that there is much more experimentation to be done.

There are new defensive weapons extensively used for the first time in this War about which we may talk freely; such weapons as those used in medicine: vaccines against diseases that hitherto were uncontrollable, the array of sulpha drugs effective against some of the great killers of war and peace, and improved methods of sanitation and prevention which, although unspectacular, serve an essential role. It is altogether possible that this will be the first war in which wounds born of battle will take a larger percentage of human toll than disease and pestilence. If we do escape a great plague, it will be a triumph for our fighters against disease—with considerable credit to the omnipresent factor of fate.

On the production front one of the great problems has been the supply of raw materials. Scientific workers and engineers, as well as industrialists, have had to do some violent readjusting of viewpoints in worrying about supplies. In the transition from an economy of plenty and oversupply to a regime of scarcity and priorities, there has been ample opportunity for high ingenuity and for realization upon many seemingly wild goose chases of the research laboratories.

Almost every day we hear of some new achievement in producing a new material for an old use or a new use for an old material. There is a new kind of glass that replaces cork as the buoyant material in life preservers—glass that is puffed up like bread dough and looks like a cinder block. Noble silver goes to work and carries electricity more efficiently than copper and is substituted for tin in solder. The normal array of alloy steels is simplified to meet the emergency situation and scarce alloying ingredients are conserved.

There is in process a revolution in food preservation that may well rival the introduction of canning that came of the Napoleonic wars. This grows out of the shortage in shipping space for overseas shipments, the lack of tin for food cans, and the rise of the quick freezing processes. Dehydration of foods of all sorts—meats, vegetables, milk—is rapidly becoming a widespread standard practice that will undoubtedly persist after the War. Plastic coatings serve in place of tin on food cans. Glass jars come into wider use.

These are random samples of some of the things that are happening in industry under the influence of the War. Some such things are born of the necessity and impetus of the War, but it should be kept in mind that war itself is a waster and despoiler in science and engineering as in almost all other things. Under the white-hot urgency of physical struggle certain developments are accelerated, but the creative beginnings usually will be found to date back to the more reasoned days of peace.

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* Based on an address delivered before the Institute of Public Affairs, University of Virginia, on July 7.

To advise is about as far as men of science and engineers can go in actually fighting the War with their new weapons. The Fighting Services must use tools furnished them. Men of science can advise with some vigour and emphasis. Secrecy is necessary, of course, to keep the enemy from knowing what is being done. But secrecy can hide inaction as well as surprising, aggressive preparation. As with production and military action, the great problem is getting there first with the most and newest, and of meeting any new scientific weapon that the enemy might spring on us with an antidote within the minimum of time. The classic example of applying the antidote in this War was the neutralizing of the magnetic mines of the Germans by the degaussing belts for ships developed in Great Britain.

The 'mental front' ranks in importance with the fighting fronts in this War. It is neglected or handled piecemeal by this and that agency because it is shapeless, permeating battle lines that exist everywhere—in the United Nations and in the occupied and enemy countries. This mental front is within each of us. It is called morale or propaganda or the war of nerves. It is full of complexities and intangibles. It provides at once the greatest drive toward victory and the speediest retreat toward subjection. It is what makes the Russians—women and children as well as men—fight in the streets and scorch the earth. It is what immobilizes and makes uninterested non-combatants out of the peoples of some countries when invaders are at their front doors. The mental front is concerned with human motivation and mass emotions. It is the great neglected area in the War because it is not made of steel or tramping men.

Because of the nature of what they work with, psychologists and psychiatrists have great difficulty in forming and maintaining the lines along which they fight effectively. In part not enough is known about why human beings do things or do not do things, why they are willing to die or why they want to run away, either in ordinary life or in war. Much more is known than is being used, although more psychologists are used in this war effort than in any other. Experts in diplomacy, economic warfare and public opinion work as artists rather than scientists. Joint efforts by artists and scientists are sometimes difficult to arrange, but when accomplished often bring worthwhile results.

As science fights the war, it is also fighting for the peace to come. If this is not the case, the peace to come will be but an armistice breeding new wars. The design of the world organization to come must be on our drawing boards as our troops fight if we are to reconstruct the world in the shape we wish. More than swift, time-annihilating aeroplanes will be necessary to bind the world together in a new democratic order.

Many of the things happening in these crowded crucial months are winning the peace at home and conducting "the people's revolution' as Mr. Henry Wallace, vice-president of the United States, has called it. To build a just, charitable and enduring peace, he has said, inspires production to the limit, transportation as rapidly as possible to the field of battle, and fighting "with all that is in us". In fighting the War, science paves the way for peace that must come. As we fight for a sane and livable world, we can be inspired by Mr. Wallace's declaration: "Modern science, when devoted wholeheartedly to the general welfare, has in it potentialities of which we do not yet dream."

THE IMPACT OF SCIENCE ON AGRICULTURE

By Sir JOHN RUSSELL, F.R.S.

IN spite of considerable diversity, agricultural systems in the pre-scientific days usually possessed two features in common: they aimed first and foremost at providing complete subsistence for the community, money crops being a subordinate consideration; and they included measures for conserving the productiveness of the land, either by the so-called fallowing, or by letting the land revert to the wild state, or by some other device. Although these systems had a low level of productiveness they provided food for indefinitely long periods of time, and in addition possessed certain social advantages. In the system followed in Great Britain, around the Baltic, in Northern India and elsewhere, the land was divided into strips which were shared out among the participants for the purposes of ensuring equitable distribution of good and bad land. The whole complex of peasant life developed some creative art which showed itself in a love of colour, folk music and dancing, embroidery, wood carving, pottery, iron work and other peasant arts and crafts.

Unfortunately, the strip system of farming was incapable of improvement by scientific means, and as soon as the peasants insisted on a higher standard of living it had to go. The method of change varied in different countries: Russia adopted one way and Poland another. Instead of scattered strips the agricultural holding was brought into one self-contained unit. Here science was able to play its part. Unfortunately, as science came in so the peasants' arts and crafts, the colour, the singing and the dancing got somehow crowded out; they ceased to be spontaneous peasant activities and are becoming only museum pieces. It would be a great advantage to the countryside if, somehow, this apparent antagonism could be overcome.

In Great Britain the change to unified holdings had been made before the scientific era and so we were able at once to introduce science into our agriculture. It led to great improvements and in the 1860's and 1870's our farming superiority was widely admitted. Then came a remarkable sequence of events illustrating the difficulty of anything less than 'total' application of science to agriculture. The prairies of North America were gradually being opened up for settlement. The development of implement design made cereal cultivation possible, while plant selection and breeding—then only in their early stages—provided suitable varieties. Transport and business agencies arranged to take and pay for the produce. A very cheap agricultural system was worked out, and the operations were on so large a scale that considerable economies were possible with the result that wheat was put on British markets at prices below those at which our farmers could grow it. Similar developments occurred in the production of butter, cheese and meat, mitigated somewhat in the latter case by the fact that British produce always had a superior quality and so had some preference in the market. Our farmers could not compete, and British agriculture fell in the 1890's to a very low level. Then a more comprehensive application of science was attempted which was gradually directed to an increase in the output per man-hour, so allowing a higher rate of wage sufficient to keep some of the men on the land. This effort was so far successful that before the War our output per man-hour was higher in money value than in any country in Europe. It proved very difficult, however, to combine this high output per man with high output per acre: indeed there appeared to be some sort of inverse relation between them. Our output per acre was considerably lower than in the smaller Western European countries of small holdings, and our agriculture remained solvent only by reducing the numbers of paid workers: in England and Wales the fall was from 803,000 in 1925 to 593,000 in 1937–38.

The increased efficiency of the worker rather more than counterbalanced the fall in numbers, so that the gross value of the output rose somewhat even after allowing for differences in price.

Meanwhile a striking change had come over large sections of the prairie regions, the development of which had been the cause of so much trouble to British agriculturists. The system of agriculture proved destructive of the soil texture, the original crumb structure broke down, the soil changed to dust and in the high winds blew away. Soil erosion took place on a gigantic scale, and vast areas fell out of cultivation, some never to come back into agricultural use so far as we can see. The United States suffered most and led the way in the search for causes and remedies. It was shown that mixed farming, with alternations of grass and arable husbandry, was the surest way of preventing erosion and the best curative treatment for land not yet ruined beyond repair. But this meant a complete change in the commercial arrangements, and a reversion to the old principles, which included farming for subsistence, and the recognition of responsibility for the conservation of the soil. Far-reaching social changes are likely to result.

A somewhat different problem arose in tropical Africa and parts of India. The climate favoured the production of certain commodities of high commercial value, such as oil, fibre, tea, coffee, etc. The large supply of very cheap native labour ensured cheap production. So a plantation industry was developed and proved highly susceptible to scientific treatment; striking developments occurred. Then, however, arose certain difficulties. These new crops, helped by the aid of science, pushed out the native food crops; the subsistence agriculture gave way before plantation cropping, and the natives received pay for their work but not food. This substitution of money for food led to social difficulties, unrest, malnutrition, etc. Further, a change in the market requirements might render the produce of a whole region more or less superfluous thereby causing great financial loss: the history of sugar-cane in the West Indies is an example. In short, the intense specialization which followed the too exclusive emphasis on efficiency of production had two grave defects: it lacked the permanency of the older system and it did not adequately provide for the needs of the community.

During the past thirty years a great change has come over our ideas of administration, and it is now recognized that subsistence farming must be fully developed so as to ensure abundance of suitable food for the home population. This is necessitating a much broader utilization of science than in the earlier days.

Even in regions of the world where plantation cropping was not practised, the limited scientific intervention first attempted led to unexpected and undesirable results. The efficient medical and veterinary services greatly reduced the incidence of human and animal disease and so curtailed an important check on the population: the numbers of men and of animals increased and put great pressure on the land. The old system of shifting cultivation which had allowed of recuperation of fertility could no longer function: soil deterioration and in many cases soil erosion set in and a crop of troubles—social and technical—arose. These have necessitated great schemes of investigation. The general result is as before the need for a more varied type of farming, making more use of grass and leguminous crops and taking other steps to ensure soil conservation; also a larger but better organized production of crops for human and animal food; this of course involves collaboration with the veterinary and the medical staffs so as to ensure that the right foods are grown.

The War has imposed upon us in Great Britain the necessity for finding some solution of the very difficult technical problem of combining high output per acre with high output per man. The fundamental difficulty is the slowness of agricultural production, which science seems powerless to hasten. In spite of a hundred years of agricultural science crops still take as long to grow as ever they did; further, a lamb still takes five months in getting born and a calf takes nine months or more: all the big vital processes are in the main outside our control. Many of them are very dependent on season. Crops and animals are rarely ready for sale in less than 15 or 18 months after expenditure on them has begun, and as it is impossible to forecast prices for so long farmers are bound to play for 'safety first'. So it comes about that well-recognized improvements cannot be adopted because of the uncertainty whether the prices ultimately obtained will justify them. Probably there is no greater cause of frustration of agricultural science than this uncertainty about prices of produce.

In war-time this difficulty disappears and farming is virtually run on contracts, like other businesses. Prices and wages are fixed, and farmers know exactly where they are and exactly how far they can go in adopting improved methods. So in spite of almost unparalleled difficulties the output per acre now seems to be rising without any corresponding diminution in the output per man. On all grounds it is essential that British agriculture should continue to function effectively after the War. It will be needed for three purposes: (1) to help in solving the difficult social problems that will certainly arise: standards of population, national nutrition, unemployment, etc.; (2) to add to the national wealth and provide food for the community; (3) to remain as an effective protection when next a military adventurer starts a war in Central Europe.

The great need after the War will be for careful planning as to what exactly agriculture in Great Britain is wanted to do. Is it to slacken down considerably to allow of heavy imports of food for the benefit of shipping and commerce, or is it to produce as much as possible? Some sort of compromise will probably be reached. If the imports of food continued to be organized centrally it should be possible to allocate the various items among the different producing countries, giving a certain share to the home farmer at a price which enables him to pay the statutory wages without having continually to reduce the number of workers. So the difficult problem of combining high output per man with high output per acre can be solved. As an insurance against starvation in the next war it will be imperative to maintain a certain level of agricultural production.

A planned agriculture would allow of the comprehensive application of science, anything short of which may, as we have seen, have unexpectedly bad results. But the planning must not destroy the individual initiative that still remains one of the most potent factors of success in agriculture.

THE FULMAR IN THE BRITISH ISLES

By SETON GORDON, C.B.E.

THE results of the investigations into the distribution of the fulmar in the British Isles which the British Trust for Ornithology undertook during 1934–39 were published as a paper in the November issue of the *Journal of Animal Ecology*, 1941 (Cambridge University Press) entitled "The Breeding, Distribution, History and Population of the Fulmar (*Fulmarus glacialis*) in the British Isles", by James Fisher and George Waterston. The report was completed by Mr. Fisher as Mr. Waterston, now a prisoner of war in Germany, handed over his share of the work to Mr. Fisher in 1938. No one interested in the fulmar should fail to read this publication, which is one of the most interesting ornithological papers of recent years.

The spread of the fulmar, an attractive ocean bird with powerful flight that is deceptive because of its grace and apparent aimlessness, is one of the most remarkable features of British bird-life during recent decades. Until the year 1877, the fulmar bred only on the St. Kilda group of islands, which rise from the bed of the Atlantic more than one hundred miles west of the Scottish mainland. Since 1877 it has founded, up and down the coasts of Britain and Eire, no fewer than 208 colonies, in which there are estimated to be some 40,500 breeding pairs. Since the fulmar lays only one egg in the course of a season, this increase is the more remarkable.

St. Kilda has now been deserted by its human inhabitants, who were accustomed to snare the adult fulmars for oil (which they used for lighting) and food; and to take the young in the downy stage for food; and presumably, therefore, the great St. Kilda colony must now be increasing each year. But the spread of the fulmar was already taking place when the St. Kildans continued to take the fulmars for their needs, although Mr. Fisher's estimate of the number of young fulmars killed on St. Kilda in 1929 exceeds, by almost two thousand, Mr. Neil Ferguson's estimate given me of four thousand young birds taken that year.

It is not, I think, disputed that a considerable proportion of the newly founded colonies must have come from St. Kilda stock, but it seems to me probable that birds which overflowed southward from the great colonies on Iceland and the Faroe Islands have contributed to the increase. Surely, by the way, it is more likely that the Isle of Skye fulmars (p. 229) are an offshoot of the considerable colony on the Shiant Islands, twelve miles to the north, rather than arrivals from more southerly latitudes as suggested. Regarding the St. Kilda fulmars, Neil Ferguson, a St. Kilda man now living on the Scottish mainland, is of opinion that their spread eastwards was due, partly at all events, to their habit of following in thousands the whales that were towed from St. Kilda waters to the whaling station in Harris. This is a possibility which must not be lost sight of in seeking for the reason of the spreading, for we are told (p. 258) that fulmars first bred on Foula in 1878 when a whale was being cut up there.

The fulmar is primarily a bird of the Arctic and my memory of it in Spitsbergen is of a mountain-nesting rather than a coast-nesting species. In Britain, too, the fulmar has now founded several inland colonies. One of them, on an isolated basaltic rock on the golf course at Bamburgh in Northumberland, has, I am told, been forsaken during the present season of 1942. At this colony during a January day of easterly storm I recall watching the fulmars flying high to a considerable distance inland from that inland cliff.

The enemies of the fulmar are indeed few, but Mr. Fisher is perhaps on doubtful ground when he makes the statement that in Spitsbergen "there is no proof that the Arctic fox ever tackles the fulmar". In "Spitsbergen Papers", vol. 1, p. 330, a short account is given of a fulmar colony on a cliff amid the inland ice of Spitsbergen and of the fox tracks in the vicinity, the inference being that the foxes were preying on the fulmars, and again on p. 333 "we were rewarded by the sight of an Arctic fox making its way at great speed towards Fulmar Cliff". No definite proof, perhaps, but I have little doubt that the Arctic fox preys upon young fulmars when it has the opportunity.

In Scotland great black-backed gulls take fulmar nestlings as food for their own young. In July 1937, on the island of Hoy, I disturbed, beside a freshwater loch, a large great black-backed colony. One of the young gulls when alarmed disgorged a complete young fulmar which it must have swallowed only a few minutes before. The neighbouring cliffs on which the fulmars were nesting had not been disturbed that day through human agency, and the inference therefore is that the parent gull must either have driven the parent fulmar from its young, or must have come upon the young one unattended. When young fulmars disappear (as they often do) from a colony, I suspect that it is the work of the great black-backed gull.

Mr. Fisher has found that the breeding colonies of fulmars arrive earlier at their rocks than the birds which are founding colonies but have not actually bred. But the small Bamburgh colony, even when that colony was in process of being founded, arrived at their inland rock so early as the end of December or beginning of January, whereas at their breeding colony in the north of Skye the birds have not been noted on the ledges before February. Perhaps the fact that the two colonies are on opposite coasts of Britain may account for this difference in the times of arrival, but it is nevertheless worth recording.

Mr. Fisher's paper is full of interesting information. Who, for example, was aware that fulmars have been on occasion shot with young peduncled barnacles growing upon the feathers of their under parts (p. 256)? Or, that a fisherman's minnow bait was taken by a fulmar on fresh water 400 miles from the sea (p. 257)? One would have liked to have been told more about that remarkable occurrence.

It is pointed out that the nesting site of the fulmar is rather different from the sites of other cliff-nesting birds, for it is usually a steep slope of 60° or more (pp. 248–49) and not a true cliff. Neil Ferguson of St. Kilda in a letter to me apropos of this writes: "I am sure the sheep on St. Kilda are now disturbing a lot of fulmars. At the time of their laying we used, as long as we lived on the island, to fence the sheep off the easiest places where they would 'spoil the fulmars' as we used to say, and used to repair the fence each season before the laying time."

On p. 249 some unusual nesting sites of the fulmar are recorded. On North Ronaldshay the species was nesting on ruined buildings in 1934, and on inhabited dwellings in 1937; on Sanda, an isle of the Orkney group, it nests on the ground among Arctic terns.

Several instances are on record of a fulmar attacking a herring gull, but the species as a rule seems to be harmlessly disposed towards its neighbours. Yet there are a number of reports to the authors of the paper that it causes other sea birds to leave the sites which it occupies.

OBITUARIES

Prof. L. Roule

PROF. LOUIS ROULE, whose death has recently been reported, was the fifth occupant of the Chaire de Zoologie (Reptiles et Poissons) at the Muséum National d'Histoire Naturelle of Paris, a chair which, as its present occupier, Prof. Pellegrin, has remarked, seems to confer the gift of longevity on its holder. Louis Roule was born in Marseilles in 1861 and studied in the school of medicine in his native town.

Prof. Roule's early zoological work was on worms and tunicates, and his doctorate, gained in 1884, was awarded for a thesis on the Ascidians of the coast of Provence. He became professor at the University of Toulouse in 1892 at the age of thirty, his duties including the direction of the station of pisciculture and hydrobiology associated with the University. It is here that the origin of Roule's interest in fishes is to be found; that he never lost interest in the economic aspect of ichthyology is evidenced by the publication in 1914 of his "Traité de pisciculture et de pêche", and the devotion of one of the ten volumes of his "Les Poissons et le Monde vivant des Eaux" to the same subject.

Nevertheless, during his tenure of the Museum chair, to which Roule succeeded in 1910, it was largely with those fishes most remote from man's practical interests that his original works were concerned. He produced important reports on the fishes collected by the French Antarctic Expedition led by Commandant Charcot, on oceanic fishes and their larvæ collected by Prince Albert I of Monaco, and on larval and adult deep-sea eels collected by the Danish oceanographical expeditions led by Johannes Schmidt. The handsome volumes published at Monaco were enhanced by the artistic collaboration of Fernand Angel, who also illustrated the work on deep-sea eels (done in collaboration with Leon Bertin) and many of Roule's smaller publications.

The strange forms and peculiar conditions of life of the fishes that dwell poised far below the broad surface of the ocean and as far above its deep floor never fail to grip the imagination of any zoologist fortunate enough to handle them. Roule was fond of generalizations, and his conception of some of the most aberrant of the bathypelagic fishes as "monstres normalisés" was characteristic. One of the ten volumes of the popular work referred to above was devoted to abyssal fishes, and another (which was translated into English) to the migrations of fishes, a subject in which he was particularly interested. The philosophical vein in all ten volumes, and particularly in the last, allows one to suppose that he offered this book, not merely as a by-product of his scientific life, but also as a summing up of his experiences, the rounding off of a satisfying career.

E. TREWAVAS.

Prof. J. H. Salter

WE regret to record the death of Prof. J. H. Salter on August 5 at the age of eighty-one. John Henry Salter was born in Westleton, Suffolk, on June 5, 1862. In 1869 his father died, and the family moved first to Woodbridge, and then to Scarborough. Dr. Salter attended Ackworth School and afterwards became an apprentice master at the school and studied at Flounders College. He graduated B.Sc. London, and taught at various schools during 1881–88. He then proceeded to Dalton Hall, Manchester, to read botany under Prof. Williamson and Mr. Hick at Owens College. In 1891 he demonstrated at University College, London, for a short time and was later appointed as the first professor of botany at Aberystwyth, under Principal T. F. Roberts. Obtaining a year's leave of absence in 1896, he went to Bonn and worked under Strasburger. He was replaced at Aberystwyth during this time by Keeble (later, Sir Frederick Keeble).

In later years Dr. Salter often spoke with pleasure of his time at Bonn, where he formed one of a group which included Harper, Swingle, Fairchild and Osterhout, as well as Schimper and V. H. Blackman. Harper, Swingle and Fairchild were studying the dividing nucleus and the spindle, Schimper was already interested in plant-geography, and Dr. Salter was investigating the connexion between pyrenoids and starch grains. His drawings were beautifully executed in water colours, and were presented by him to the Botany Department of the University College of Wales, Aberystwyth, a week before his death. During the time that Dr. Salter worked under Strasburger, he learned from him the method of preparing herbarium sheets which he used and developed for the rest of his life. The plants were pressed between layers of cotton wool, each overlapping leaf was separated by a slip of drying paper, and the finished specimens showed all the care of the master hand. He specialized in Salix and Mentha, as well as collecting a large general herbarium, which he gave to the National Museum of Wales, Cardiff, a few months ago.

In 1897 he returned to Germany to work with Meyer at Marburg on the interrelationship between the algal and fungal components of lichens. He was convinced that the fungus obtained food from the alga, and his drawings, executed with meticulous care, form part of his recent gift to the University of Wales, Aberystwyth.

He married Adah S. Freeman of Birmingham in 1899. In 1908, he resigned from the chair at Aberystwyth, on account of a breakdown in his wife's health, and the family moved first to the Canary Islands, and then to the south of France. These countries gave wide scope for his interests and he added the record of several new species to the flora of the Canary Islands, as well as continuing his studies in conchology, ornithology and entomology.

The family returned to England in 1916 and, after his wife's death in Dorsetshire, he returned to Aberystwyth in 1923 and settled at Llanbadarn Fawr. During the succeeding years he walked for miles among the mountains and vales of the Aberystwyth district and his wide knowledge of the flora was partly collected together in "The Flowering Plants and Ferns of Cardiganshire" which he wrote in 1935. His knowledge of bird life was very considerable, and he was instrumental in initiating the movement for the preservation of the Welsh kite in the Towy valley. He also made a collection of insects which is to be given to the National Museum of Wales, Cardiff.

Since his return to Wales, Dr. Salter has taken a keen interest in his garden, where he has kept records of the flowering periods of some six hundred plants. From the age of seven until the day before his death he kept a natural history diary, which is full of information on birds and plants. The volumes, beautifully written in his neat script, are to be housed in the National Library of Wales.

Dr. Salter was a member of the Society of Friends and a man of the highest principles. He was quiet and reserved in manner, but his knowledge was always freely at the disposal of those who sought it. The fragrance of flowers, the first seasonal appearance of a plant or a bird gave him profound pleasure. No trouble was too great for him if information was desired on a subject with which he was familiar. His tall spare figure will be greatly missed from the Aberystwyth district, for he walked easily, and regularly took a twenty-five mile walk until quite recently.

His passing means that many records will inevitably cease to be collected, for he devoted his whole time to work; it means that many of us will no longer have a fount of wide information generously at our disposal; and it means also that we shall be denied the privilege of his pleasure when an interesting plant is found. He was a true man of science, a seeker after truth in every sense of the word. It has been a source of deep regret to his friends that the last few months have demanded from him inactivity and suffering.

He was laid to rest at Llanbadarn Church on August 8. He is survived by two sons, one of whom is in Canada. As scientific workers we share with them some of the privileges of having known and learned from him. LILY NEWTON.

Mr. T. Harris

MR. T. HARRIS, who has recently died, joined the Research Department, Woolwich, in January 1921 at a time when the importance of the scientific approach to problems of war and defence was beginning to be realized. He became a member of the Ballistics Branch and immediately began experimental work of a fundamental character, to which he brought with enthusiasm his wide knowledge of physics and his skill as an investigator.

The policy in those early days was to build for the future, and it was wisely decided that long-term researches should be undertaken to lay sure foundations for further development. Most of Harris's energies were devoted to such work, and in the course of time he brought to fruition several of these projects about which, because of necessary secrecy, it is impossible to give much detail. It may, however, perhaps be permitted to mention the following items which he either initiated or whose development was directed by him: muzzle vibrations of rifles; temperature of combustion of propellants; development of methods of photography of bullets in flight, both by single and multiple-spark photography; recoil problems—muzzle and chamber brakes; general internal ballistics of small arms. He was responsible for developments and improvements which have been embodied in weapons in use in the present War.

Harris's methods were essentially sound—careful, meticulous consideration of all aspects of the problem, never rushing to conclusions, and making sure of each step before proceeding further, and it should be said that his mathematical knowledge was considerable and was used with skill to keep theory and experiment in close touch.

The outbreak of war brought heavy demands on his strength and when he and his work were moved from Woolwich in September 1940 he was already a sick man. He never complained and gave unstintedly of his best to ensure the continuation of the investigations, but it was clear that the effort was costing him dear. He lived long enough to see things going satisfactorily at the new station, but a bad breakdown in July 1941 kept him away from work for about six months, and, although he struggled back for a few days in January 1942, it was apparent to all that the end was near. He inspired respect and affection in all his colleagues, and, to the writer of this notice in particular, he was a close and loyal friend, ungrudging in advice and help at a very difficult time. The country and the national war effort are the poorer by his death. C. A. C.

Dr. Arnold Berliner

IN connexion with the obituary notice of Dr. Arnold Berliner (NATURE of September 5, p. 284), Mr. F. I. G. Rawlins writes: In the summer of 1928, the University of Berlin gave an *Abendessen* to graduate students attending the *Ferienkurs* in theoretical physics. Prof. von Laue was host, and I sat next to Arnold Berliner. His conversation was brilliant, over a wide range of topics, and his enthusiasm for straightforward scientific literature unbounded. A few years before he (with Karl Scheel) had produced the monumental "Physikalisches Handwörterbuch", in which I ventured to point out a few (obvious) omissions. He replied at once—"I prepare a new edition, and I promise that there shall be no gaps". Most of the evening, he continued to discuss everything conceivable, but not without betraying some strange—and even violent—likes and dislikes, doubtless the outlet for the "artistic temperament" which filled his whole being. He stood four-square for a culture altogether too broad and too magnanimous ever to suffer complete eclipse.

WE regret to announce the following deaths:

Prof. L. Aschoff, professor of pathological anatomy in the University of Freiburg im Breisgau, aged seventy-five.

Dr. S. G. Barker, O.B.E., scientific adviser to the Indian Jute Mills Association, on August 28, aged fifty-five.

Dr. H. C. Lawrence, formerly of the Imperial Forestry Service, Burma, on August 25, aged sixty-seven.

Mr. P. A. Mytton, O.B.E., chief livestock officer for England and Wales, Ministry of Agriculture, on September 3, aged sixty-one.

Mr. Bernard Neville, formerly physics master at William Ellis School, aged fifty-five.

NEWS and VIEWS

Imperial College of Science and Technology: New Rector

PROF. R. V. SOUTHWELL, who has been appointed rector of the Imperial College of Science and Technology in succession to Sir Henry Tizard, who was recently elected president of Magdalen College, Oxford (see NATURE of August 1, p. 148), has behind him a distinguished career in the field of engineering science, starting with the award of a fellowship of Trinity College, Cambridge. At the outbreak of the War of 1914–18, Prof. Southwell had already made a name for himself as a research worker in the theory of elasticity, and this subject has remained his strongest interest in academic life. In the last few years he has made available a powerful method of solving problems otherwise intractable, by a system of successive approximations. Problems involving strains of materials or motions of fluid come within its scope, and solutions are now prominently identified with the Engineering School at Oxford.

In his wider scientific activities, Prof. Southwell has been intimately connected with aeronautical developments; during the War of 1914–18 he interested himself actively in the construction of airships before taking executive control of the Aerodynamics Department of the Royal Aircraft Establishment and its research into the characteristics of heavier-than-air craft. In the reconstruction period, Prof. Southwell transferred to the National Physical Laboratory as superintendent of the Aerodynamics Department and has since maintained his contact through his membership of the Aeronautical Research Committee; after five years as superintendent he returned to Cambridge as a University lecturer in mathematics, and a little later became professor of engineering science in the University of Oxford.

Besides his assistance to aeronautics, Prof. Southwell has aided other Government departments, such as the Ministry of Home Security and the Department of Scientific and Industrial Research. He has represented Great Britain on international committees, notably one on applied mathematics founded after the War of 1914–18 to bring former enemies into renewed scientific contact. His ability has been recognized by degrees conferred, and his outstanding value to engineering science by election to fellowship of the Royal Society in 1925. No doubt Prof. Southwell will receive a warm welcome at the Imperial College and will be a valuable asset to the University of London.

Science and the War Effort

AT a meeting of the Parliamentary and Scientific Committee held at the House of Commons on September 9, the recent appointment of three full-time scientific advisers to the Ministry of Production was considered and the following resolution was passed: "This committee, while welcoming the appointment of three full-time scientific advisers to the staff of the Ministry of Production in so far as it establishes the nucleus of a central scientific and technical board, regrets that their field of activity is apparently to be limited to the sphere of production and does not include the scientific and technical activities of the service Departments or the other Ministries outside the strict field of production. An extension of its functions is needed to ensure that all scientific considerations are co-ordinated and given full weight over the whole field of the national effort. The committee considers, therefore, that in order to cover this wider field, scientific advisers should have direct access to the War Cabinet and that accordingly the Lord Privy Seal should exercise his supervisory functions over the new body directly on behalf of the War Cabinet."

It was also announced that 126 members have now added their names to the motion on the Order Paper, which suggests that "present circumstances require the early establishment of a whole-time Central Scientific and Technical Board to co-ordinate research and developments in relation to the war effort."

A Promise to Youth

AT a meeting on September 3 of an international assembly of students made up of delegates from all the United Nations, President Roosevelt gave a pledge for the future to the youth of the world—to those who must bear the brunt of the physical warfare and who will shape the new world. He referred to the glorification of youth in which the Axis Powers have always indulged; so far from their being the real champions of youth, it is now seen they have nothing to offer save death. "On the other hand", he said, "the cause of the United Nations is the cause of youth itself." The thoughts of many are concerned with interrupted education and careers and the postponement of opportunities in life; but as, under the stress of war, the American Government has accepted the broad responsibility of seeing that suitable work shall be provided for its citizens, so in days to come that responsibility will be continued. Victory is essential, but is not enough; we must ensure the 'four freedoms' for the generations to come, and it will require "bold vision, intelligent planning, and hard work". This applies equally to all the United Nations, and involves a step of historic importance; for it means that the needs of humanity have brought together the cultures of the Americas, Asia and Europe to form for the first time a world civilization. The principles set out in the 'four freedoms' and in the Atlantic Charter as a whole provide for a world in which all may live in freedom and equity, and without fear of war. They will not be easily established, even when the War is won, but the mistakes of the aftermath of the War of 1914–18 will not be repeated. Through these principles we have the possibility of reaching the highest goals that mankind has ever imagined.

Reservation of Students in the United States

DEFERMENT of calling up for service in the American fighting forces is recommended in an *Occupational Bulletin* circulated by the Selective Service Organisation for students in training for certain sciences as well as for scientific men now engaged in critical war research work. It applies to the sciences and specialized fields certified by the National Roster of Scientific Personnel as requiring long periods of training and as being work for which the necessary man-power does not already exist to meet war production and activities essential to the war effort. They are: accountants, chemists, economists, engineers (aeronautical, automobile, chemical, civil, electrical, heating, ventilating, refrigerating and air-conditioning, marine, mechanical, mining and metallurgical including mineral technologists, radio, safety and transportation), geophysicists, industrial managers, mathematicians, meteorologists, naval architects, personnel administrators, physicists, astronomers, psychologists and statisticians. Careful consideration for occupational classification should be given, the bulletin says, not only for men already engaged in these activities necessary to war production or essential to the war effort, but also to undergraduate college students in training for them if they are in their junior or senior years, or at or near the close of the sophomore year. A graduate or post-graduate student who is undertaking further studies for these scientific and specialized fields may be considered for occupational classification if, in addition to his studies, he is also acting as graduate assistant in a recognized college or university, or is doing war research which is supervised by a federal agency. After a student graduates, it is recommended that he should be given sixty days additional deferment to give him time to enter war production or other war work.

University of Durham : Chair of Child Health

THE University of Durham has received an offer from the Nuffield Provincial Hospitals Trust to provide a grant of £15,000 towards the cost of establishing a chair of child health at King's College, Newcastle-on-Tyne. The Senate and Court of the University have accepted the proposal with gratitude. Dr. J. C. Spence, lecturer on the diseases of children, has been appointed to the chair, and the Council of King's College has expressed its intention to provide him with the assistance necessary for creating a full teaching and research department. The department will provide undergraduate and post-graduate teaching in child health and the diseases of childhood, will be a centre of research, and will be at the disposal of local public health and education authorities of the region for advice and consultation in the conduct of their child welfare and school medical services.

Simplification of Musical Notation

A MODERN writer has declared that the orthodox musical notation is "in some of its elements, foolishly illogical and unnecessarily complicated" (W. R. Anderson, in "The Musical Companion", Gollancz, p. 27), and in recent correspondence in NATURE, concluding with the present issue, correspondents have suggested simplifications. Many attempts have been made to do this in the past, but have failed to gain permanence. One of the most widely advertised, which appeared some thirty years ago, was known as Naunton's National Music System, a fundamental element of which was a simplified notation without clefs, sharps or flats. The score consisted of horizontal lines drawn from the black notes of a keyboard shown vertically on the left. Thus, black lines corresponded to *black* keys and white spaces to *white* keys. The main object of this notation was to enable the average person to become a proficient pianoforte player from a score, the precise object sought by Lord Brabazon in the original letter of the correspondence published in NATURE of May 16.

The discussion which has since taken place shows that one of the principal difficulties has been the possibility of the existence, side by side, of a standard and a simplified notation. There can be no question of the scrapping of the standard notation, which indeed enjoys the almost unique distinction of universal acceptance—in fact, it is a form of international language. To make basic changes in such a universal notation would involve the scrapping of countless costly plates and stocks, while the effect upon musical organizations would be disastrous. The musician should, however, consider the needs of the weaker brethren, who have neither the aptitude nor the time to study the finer points of music, yet wish to be able to 'make music' for themselves from time to time. Would a simplified notation contribute to this end ?

Very little has been said in this correspondence about the intricate problem of playing, but it should suffice to point out that ability to read a score does not carry with it even the simplest keyboard technique ; many moderate players cannot read, while it is quite possible for a non-player to be a fairly good reader of music. In interpreting a score at the keyboard, a vocabulary of simple chords is a *sine qua non* and, to gain this, it is worth while for a beginner to experience the joy of becoming intelligently acquainted with those delightful elements of musical composition. After all, the chords will remain unchanged whatever the notation. "If the art", says Sir Hubert Parry, "is worthy of the dignity of human devotion, it is worth considering a little seriously" ("The Evolution of the Art of Music", Kegan Paul, p. 337).

Leprosy in Brazil

ACCORDING to Eunice Weaver, president of the Federation of Societies for the Welfare of Lepers (*Bol. Of. San. Panamericana*, 21, 569 ; 1942), the total amount spent by the Brazil Federal Government for Leprosy Control was 3,584,000 dollars, of which 2,336,732 were devoted to the construction and operation of leprosaria, and the rest to research and contributions to societies for assistance to lepers and their families. On December 31, 1941, there were 15,991 patients segregated in the twenty-five Brazilian leprosaria. Federal and private contributions have permitted the establishment by various relief societies of preventoria for healthy children of lepers, in which 1,200 children are now sheltered, 1,100 more being expected. The National Leprosy Service will also contribute scientifically and financially in the installation of dispensaries and the erection and enlargement of leprosaria and preventoria.

Announcements

DR. T. ROYDS, formerly director of the Kodaikanal and Madras Observatories, has been appointed professor of astronomy in the University of Istanbul.

ONE or more research scholarships will shortly be awarded by the Royal College of Surgeons of England. The scholarships will probably be of the annual value of £400 with an allowance not exceeding £100 for expenses of research, and will be for one year, in the first instance, but renewable at the discretion of the Council. Scholars may be male or female, and must hold a medical qualification registrable in the United Kingdom or a university degree. Faculties for laboratory research will be provided in the Bernhard Baron laboratories of the Royal College of Surgeons, now evacuated to Finchingfield, Essex. Further information can be obtained from the Bernhard Baron Research Professor, at Prospect House, Finchingfield, Braintree, Essex. Applications must be made before September 19.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Lactation and Reproduction on Highly Purified Diets

NAKAHARA *et al.*[1] have claimed the existence of specific lactation vitamins, factors L_1 and L_2; they state that, if these are missing from the diet, rats will reproduce but not lactate. We[2] used a diet which was unlikely to contain these factors, but failed to confirm the finding of the Japanese workers. The recent report, by Rogers *et al.*[3], of the successful rearing of two generations of mice on a highly purified diet is of obvious interest in this connexion. We therefore think it opportune to report on experiments of our own in which three generations of rats have so far been born and reared on highly purified diets.

Description of rats	Diet	No. of animals	No. of litters born and av. no. live pups born per litter*	% pups reared	No. of litters reared and av. no. pups weaned per litter	Av. weaning age (days)	Av. weaning weight (gm.)
			FOUNDATION STOCK				
(*a*) Stock colony does	Stock	8	7; 10·8	75·0	7; 6·0	21	41·2
(*b*) Stock colony does	*A*	8	8; 5·9	34·8	3; 5·3	30	29·4
			1ST GENERATION				
(*c*) Progeny of (*b*) ..	*A*	10†	10; 5·4	15·1	2; 4·0	27	39·5
(*d*) Progeny of (*b*) ..	*B*	6	6; 7·2	41·5	3; 5·7	30	32·8
			2ND GENERATION				
(*e*) Progeny of (*c*) ..	*A*	2‡	2; 8·5	0§	—	—	—
(*f*) Progeny of (*c*) ..	*B*	2‡	1; 8·0	0‖	—	—	—
(*g*) Progeny of (*d*) ..	*A*	3	3; 9·0	25·0	1; 6·0	29	26·3
(*h*) Progeny of (*d*) ..	*B*	3	3; 6·2	27·8	1; 5·0	26	28·8

* Larger litters were reduced to 8 at birth.

† Four of these animals are referred to in both of lines (*c*) and (*d*) since they produced their first litters on diet *A* (of these, two were the only ones reared on this diet) and their second litters on diet *B*.

‡ One female still to be mated.

§ One female afterwards reared, out of eight pups, one ♀, weighing 49 gm. at 33 days.

‖ One female afterwards reared, out of seven pups, two ♀♀ and one ♂, weighing 169 gm. at 44 days.

Two main experiments are in progress in each of which the foundation stock consisted of litter-mate stock colony does weaned on to the stock diet[2] or to a highly purified diet (diet *A*) consisting of sugar 60, casein (flavin-free) 20, lard 3, groundnut oil 12, salts 5 and supplemented by aneurin, riboflavin, vitamin B_6, nicotinic acid, inositol, choline, Ca-pantothenate, *p*-aminobenzoic acid, 2-methyl 1 : 4 diacetyl naphthohydroquinone, cod-liver oil and α-tocopherol, the last two being administered on different days[4]. In view of the claim[5] that it is essential to add cystine to casein diets to obtain normal lactation in the rat, some animals received the above diet supplemented with 0·2 per cent cystine (diet *B*).

The results so far obtained in one of these experiments are summarized in the accompanying table which, except where otherwise stated, only relates to the first litter of each female. In all cases the females on the experimental diets were mated with stock colony bucks.

It is evident that the lactational performance of rats receiving the purified diet was always inferior to that of females fed on the stock colony diet. No very definite conclusions can be drawn with regard to the effect of cystine on lactational performance, but the fact that a considerably larger percentage of pups was weaned on diet *B* suggests that it exerted a beneficial effect.

Notwithstanding that lactation on the experimental diets is sub-normal, members of all four subgroups of second generation females have weaned pups, so that three generations have been reared so far on highly purified diets in the absence of factors which might be said to be specifically required for lactation.

The experiments are being continued and will be fully reported elsewhere. The helpful advice given us by Dr. T. F. Macrae is gratefully acknowledged.

S. J. FOLLEY.
K. M. HENRY.
S. K. KON.

National Institute for Research in Dairying,
University of Reading.

Aug. 12.

[1] Nakahara, W., Inukai, F., Kato, S., and Ugami, S., *Sci. Pap. Inst. Phys. Chem. Res. Tokyo*, **29**, 47 (1936).

[2] Folley, S. J., Ikin, E. W., Kon, S. K., and Scott Watson, H. M., *Biochem. J.*, **32**, 1988 (1938).

[3] Rogers, L. K., McElroy, L. W., and Cowgill, G. R., *Science*, **95**, 203 (1942).

[4] Mackenzie, C. G., Mackenzie, J. B., and McCollum, E. V., *J. Nutrit.*, **21**, 225 (1941).

[5] Sure, B., *J. Nutrit.*, **22**, 491 (1941).

A Simple Method for Enzyme Concentration

A METHOD for the concentration of enzymes and other biological colloids was recently described by Guy E. Youngbourg[1]. By this method the volume of the active solution is reduced by dialysing it against a concentrated solution of dextrin. In a previous paper[2] concerning the concentration of taka-diastase it was shown that this method was impracticable for sugar-hydrolysing enzymes, owing to the diffusion of part of the dextrin into the solution. Seeking other methods of concentration, we succeeded in finding a simple procedure by dialysing against 96 per cent ethyl alcohol or acetone as the 'outside solution' (provided only that the active substance is not inactivated by them). By this procedure the volume of the active substance is rapidly reduced. A partial precipitation from the solution during concentration sometimes occurs, but does not interfere with the final result.

The alcohol or the acetone can be regained each time by redistillation and used again. By this method dialysis can be carried out at room temperature without any danger of bacterial infection because of the alcohol or acetone medium in which the dialysis is made.

No inactivation during the experiment was observed. The enzyme solution is poured into a Cellophane bag, the mouth of which is tied securely about a glass tube made of a test tube, large enough to permit the addition or removal of the solution. The Cellophane bag with its protruding glass tube is suspended within a tall beaker into which the alcohol is introduced, submerging the Cellophane bag and its contents and allowing diffusion of the water from the solution into the alcohol. For about 50 ml. of solution being concentrated we used 200 ml. alcohol. Within 3–8 hours the original volume is reduced to about one tenth. If the alcohol is changed two or three times, the time of concentration is reduced by half.

Part of the enzyme is precipitated during concentration and forms a deposit on the Cellophane. The concentrated solution is taken out by a pipette or by tearing the Cellophane, and precipitated with an equal volume of absolute alcohol or acetone. After centrifugation and washing with ether, the substance and the Cellophane coated with the active substance are dried in a desiccator over sulphuric acid.

It is possible by dialysing over a longer time to remove completely all the water of the active solution and to obtain the active substance as a precipitate on the Cellophane. After drying the Cellophane in the desiccator or in air, the substance can easily be separated from the Cellophane. If but minute quantities of enzyme were in the solution the dried Cellophane with the deposit on it can be introduced in water which dissolves the substance. We employed this procedure for the concentration of taka-diastase, pancreatin, pepsin (all from Parke Davis and Co.) and yeast extract protease, as well as in preparing papain from *Carica papaya* latex from Jericho, Palestine, for which I am indebted to the Department of Agriculture of the Palestine Government.

All the enzymes were obtained in a dry, active form. It remains still to be seen whether the method may be employed for the concentration of desmolytic enzymes as well as other biologically active substances.

Jacob Feigenbaum.

Chemical Department,
Cancer Research Laboratories,
The Hebrew University,
Jerusalem.

[1] Youngbourg, Guy E., *Science*, 94, 498 (1941).

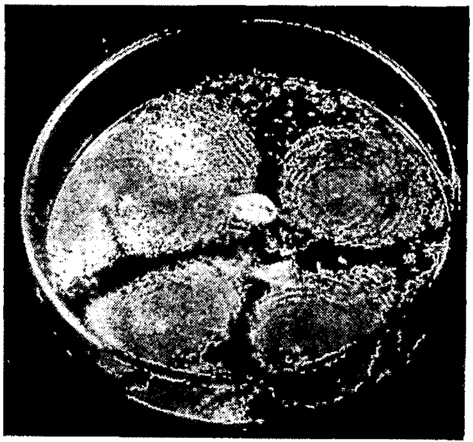
[2] Feigenbaum, J., *Science* (in the press).

A Mucorine Parasite on Penicillia

In the course of blowing experiments on air-dried soils, by use of an adaptation of a simple type of 'spore-blower' recently described[1], a growth of Piptocephalis was obtained which proved to be parasitic on Penicillia.

This has now been in culture for more than a year. The original Penicillium from the soil, on which it was first found, has not yet been satisfactorily named, but the parasitism of the Piptocephalis on it has been fully confirmed by observation. The parasite has also been obtained in culture on a number of other unnamed Penicillia, and on the following named cultures: *Penicillium roqueforti, P. notatum* (Fleming's strain), *P. pfefferianum, P. glabrum.* It has failed to grow on *P. camemberti*, on a member of the Biverticillata Symmetrica, on several fasciated Penicillia, and on a number of common Hyphomycetes of different genera.

Among the Mucorales it has so far been obtained in growth on *Mucor mucedo* + and —, and *M. hiemalis* + and —, but has not grown on a wide range of other Mucorales. Growth on the Mucors is distinctly sparser than on the Penicillia, on which it is dense and luxuriant.



Piptocephalis sp. on Penicillium

The Piptocephalis does not correspond closely to any described species, but it is nearest to *P. Tieghemiana* Matruchot[2]. Its special interest lies in the fact that, so far as I can discover, no mucorine parasite has hitherto been reported as growing on a mould other than another member of the Mucorales. Matruchot, in 1903[3], based his view that Cunninghamella is a member of the Mucorales chiefly on its ability to act as host to *P. Tieghemiana*, which would grow only on Mucors, and in most works dealing with it the genus Piptocephalis is said to be parasitic only on the Mucorales.

The breaking down of this generalization may perhaps lessen the imaginary gap between the Mucors and the Plectomycetes, and at the same time discourage the tendency to regard mucorine parasitism in general as a phenomenon related to sex and based upon close physiological relationship.

So far as can be seen at present the ability to support this parasite cuts across the ordinary divisions of the Penicillia, and it is possible that, since the parasitism when it occurs appears to be strongly marked, and to result in a conspicuous growth of white (ageing to buff) 'conidiophores' above the host (see photograph), it might provide in some cases a useful additional character for distinguishing Penicillia.

Since this note has gone to press the Piptocephalis has been obtained in profuse growth on *Aspergillus niger*. This enlarges considerably the scope of its parasitism.

A detailed study of its morphology is now being undertaken by Miss M. P. English.

C. G. Dobbs.

Botany Department,
King's College, London.
(At the University, Bristol, 8.)

August 12.

[1] Dobbs, C. G., *New Phytol.*, 41, 63 (1942).

[2] Matruchot, L., *Bull. Soc. Mycol. de France*, 16, 58 (1900).

[3] Matruchot, L., *Ann. Mycol.*, 1, 45 (1903).

Plant Ecology of Bombed Sites

Many of the unsightly scars left by the air-raids on London are now being hidden by a carpet of vegetation. Some notes on its growth on a small bombed site in a terrace in the heart of Kensington may be of interest. A three-storied corner house with a basement area and no front garden of any kind was completely destroyed by a direct hit in September 1940, but the site and that of the adjacent damaged house was not cleared until the autumn of 1941. It was then fenced off by a wooden paling which enclosed the former stretch of pavement in front of the two houses.

At that time there was scarcely a trace of plant growth. Now the site is gay with blossom. For the past six weeks there has been quite a mass of the handsome pink rosebay (*Epilobium angustifolium*) growing 3 ft. tall, which is becoming one of the most abundant weeds of waste ground and neglected gardens in London, no doubt owing to the wide distribution of its light tufted air-borne seeds; but what is more remarkable, there are no less than twenty strong young shrubs of *Buddleia variabilis* coming up, the largest of which, growing on the site of the former pavement, are now coming into flower. One of them is already six feet high and has, in flower and bud, thirty-six heads of bloom, some of them nine inches long. The nearest possible parent plant which I have been able to trace is fully a hundred yards away.

Altogether there are twenty-two different species at present in flower on the site, belonging to ten natural orders (9 composites, 3 grasses, 3 species of Epilobium, 1 Crucifer (shepherd's purse), 1 Caryophyllaceæ (chickweed), 1 Leguminosæ (clover), 1 Plantaginaceæ, 1 Chenopodium, 1 Polygonum, 1 Loganiaceæ (Buddleia), besides thick patches of moss with fruiting capsules).

Mabel Hartog.

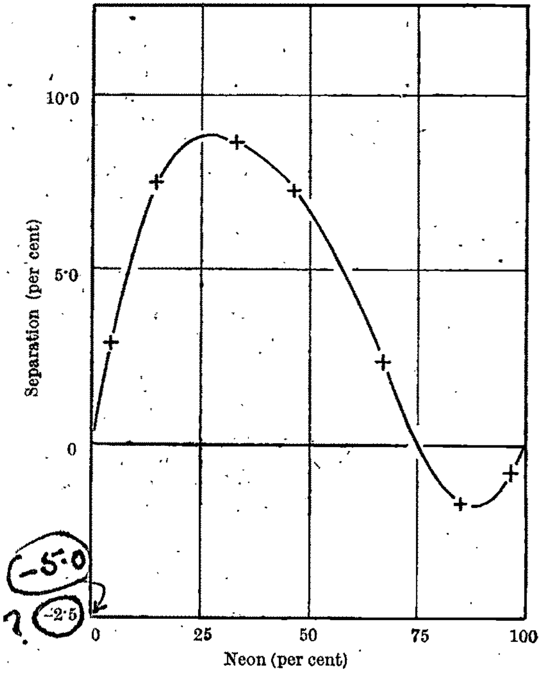
5 Inverness Gardens,
W.8
August 17.

Change of Sign of the Thermal Diffusion Factor

The change of sign of the thermal diffusion factor α with composition, which Prof. S. Chapman[1] has pointed out is theoretically possible in certain conditions, has been found to occur in neon-ammonia mixtures recently examined.

In a mixture of molecules differing slightly in mass and interaction, the thermal diffusion factor α may be considered approximately as consisting of three terms. Two of these terms represent the contributions of the mass difference and of the diameter difference of the molecules; the third involves the force index and the departure of the mutual collision diameter s_{12} from the mean diameter $(s_1 + s_2)/2$. This third term, unlike the others, depends on the concentration; although small when the mass contribution and the diameter contribution are of the same order but opposite in sign, it may suffice to bring about a change of sign of α as the composition of the mixture varies. The neon-ammonia mixture is one of few in which the mass difference is small and the heavier molecule is the smaller, so that it satisfies at least the requirement that the mass and diameter contributions should be opposite in sign.

Mixtures of various composition were examined, a Clusius-Dickel column (made in Pyrex glass) being used to increase the separation due to thermal diffusion alone, as this is too small to measure by the direct method used hitherto. Since the direction of the longitudinal concentration gradient which is set up in the column is determined by the direction of the thermal diffusion transversely, and this in turn is determined by the sign of α, a change in the sign of α would appear as a change in the direction of the concentration gradient. The experimental results are shown in the figure, where the separation, that is, the difference in percentage composition at the upper and lower ends of the column is plotted for mixtures of varying composition. Between 0 and 75 per cent neon, the neon concentrates at the upper end of the column. This means that the heavier, neon, molecule diffuses up the temperature gradient—a direction of diffusion, it is believed, not hitherto observed. Above 75 per cent neon, the neon concentrates at the lower end, indicating that the sign of α is now changed.



K. E. Grew.

Physics Department,
Heriot-Watt College,
Edinburgh.
August 10.

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[1] Chapman, S., Nature, 146, 431 (1940); *Proc. Roy. Soc.*, 177, 38, (1940).

Abnormality of Flame Gases

It is becoming increasingly recognized that flame gases (that is, the gases left behind after flame has travelled through an inflammable mixture) hold a latent energy (which may amount to as much as 20 per cent of the heat of combustion or even more), and in virtue of this an abnormal amount of dissociation obtains in them[1]. In the absence of surface, the latent energy has an exceedingly long life. It has been observed to exist *in sensibly undiminished amount* for at least 0·5 sec. Luminosity experiments indicate that it still persists even after 14 sec. (and probably much longer); and it survives the cooling of the flame gases by adiabatic expansion, for subsequent recompression restores the luminosity[2]. It seems clear that it resides in the newly formed tri-atomic molecules as an excess of intra-molecular energy held in some manner or other in very stable fashion. It was suggested that a proportion of these molecules are meta-stable molecules probably of abnormal structure[2]—a proportion which varies with the conditions obtaining during combustion, for the amount of latent energy varies with these conditions[3].

Gaydon[4], from his recent interesting investigations into the origin of the spectrum from carbon monoxide flame gases, has arrived at the conclusion that, while the newly formed carbon dioxide molecules may be of the electronically excited (tri-angular) variety, a transition to the ground state rapidly takes place, and the molecules are left in a highly vibrationally excited state. He believes that there may be a lag in the partitioning of the excess vibratory energy, and that as there is continual recombination proceeding after dissociation, an excess of vibratory energy would be maintained for a period of time which would account for the long-lived latent energy. He finds support for his view from the fact that hydrogen and water vapour decrease the latent energy in carbon monoxide combustion, and that this correlates with the well-known experiments of Garner and his colleagues, which showed that these substances greatly reduce the (infra-red) radiation from carbon monoxide explosions.

I can find no support from the radiation experiments of David and Parkinson[5] for the view that the carbon dioxide molecules in flame gases hold an excess of vibratory energy of a type which gives rise to infra-red radiation (2·8 μ and 4·4 μ); indeed, these experiments suggest that a rapid partitioning of the vibratory energy takes place, and that the amount of this energy is at all times after combustion governed by the flame gas temperature. The experiments further indicate, I think, that erroneous deductions have been drawn from Garner's experiments. The decrease in the radiation on the addition of hydrogen and water vapour would appear to result entirely from more rapid cooling. It has been shown[6] that the faster the speed of an explosion the greater the turbulence set up in the resulting flame gases, and, therefore, the more rapid the cooling. The step in Garner's radiation curves may be correlated with the sudden increase in the speed of the explosion at a critical addition of hydrogen.

Experimental work performed during the last fifteen years would appear to be more satisfactorily explained in terms of the abnormal structure hypothesis, the abnormal molecules (which in the case of carbon dioxide may be of the triangular type) reaching the ground state only when they come in contact with a surface or *when two of them possessing sufficient energy collide*. In the latter event the emission of radiation in the luminous region takes place. In this connexion it is of interest to note that flame gases with any given latent energy content emit luminous radiation with an intensity which is dependent upon the gas temperature[2].

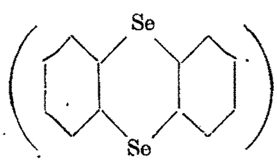
It may be added that a latent energy exists in hydrogen and hydrocarbon flame gases as well as in carbon monoxide flame gases, and, indeed, the spectrograms of Kitagawa and Gaydon from hydrogen flame gases suggest the presence of activated water molecules[4]. Usually it is much less in the former than in the latter for reasons which have been discussed[1,7], but there is reason to suppose that it may be very large even in hydrogen flames when they are burnt at low pressure. It is of interest to note that water vapour reduces the latent energy not only in carbon monoxide flame gases but in hydrogen flame gases also[7].

Engineering Department,
University, Leeds.
August 12.

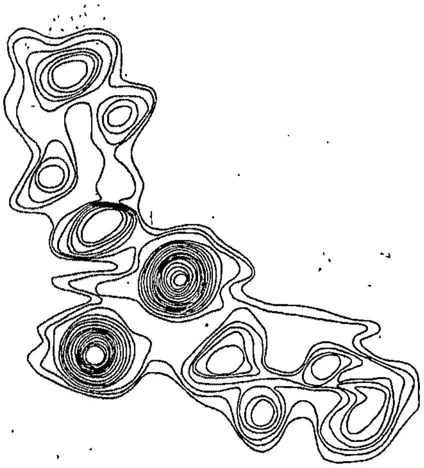
W. T. DAVID.

[1] David, Leah and Pugh, *Phil. Mag.*, **31**, 156.
[2] David and Davies, *Phil. Mag.*, **9**, 390 (1930).
[3] *Engineer*, **171**, 268 (1941).
[4] "Spectroscopy and Combustion" (Chapman and Hall, 1942).
[5] *Phil. Mag.*, **15**, 177 (1933).
[6] David and Leah, *Proc. Inst. Mech. Eng.*, **143**, 289 (1940).
[7] David, *Proc. Inst. Mech. Eng.* (in the press).

Folding of the Selenanthren Molecule

It is generally accepted that the molecule of selenanthren 

is folded about the line joining the selenium atoms, but no experimental data have so far been obtained which would give the actual value of the angle of fold, although estimates have been given[1]. It has also been suggested that the selenanthren molecule is not rigid but is flexible about the line of folding[2].



Projection of selenanthren molecule on (010) plane

In continuation of the work on the crystal structure of selenanthren already published[3], we have made a projection of the unit cell on the (010) plane. This projection was made by Fourier synthesis using photographically measured intensities of reflexion of X-rays on a monochromatic Weissenberg photograph. The appearance of the projected molecule is shown in the diagram. A single projection is of course insufficient for a complete determination of the atomic co-ordinates, but if it is assumed that the benzene rings are regular plane hexagons of side 1·41 Å.[4] the following results are obtained:

(1) The angle of fold of the selenanthren molecule about the line joining the selenium atoms is 127°.

(2) The interatomic distance carbon-selenium in the molecule is 1·96 A.

(3) The valency angle of selenium is 96°.

A small change in the assumed carbon-carbon distance in the benzene ring has little effect upon the calculated values. Thus for an assumed distance of 1·39 A. instead of 1·41 A., the three quantities become 127°, 1·97 A., 97° respectively.

A full account of the work will be published as soon as time permits.

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University College,
Cardiff.

GORDON WILLIAMS.

King's College,
London
(at the University,
Bristol, 8).
August 10.

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[1] Campbell, Le Fèvre, Le Fèvre and Turner, *J. Chem. Soc.*, **404** (1938).

[2] Higasi, *Sci. Pap. Inst. Phys. and Chem. Res., Tokyo*, **38**, 331 (1941).

[3] Wood and Crackston, *Phil. Mag.*, **31**, 62 (1941).

[4] Robertson, *Proc. Roy. Soc.*, A, **140**, 79 (1933).

Publication of Scientific Research carried out in Industry

ONE point bearing on Sir Lawrence Bragg's address on "Physicists after the War" (NATURE, July 18, p. 74) which should be noted is the practice of many British firms of refusing publication of research carried out by their staffs. Each year a considerable amount of scientific investigation is carried out by research workers in industry, the results of which remain quite unknown to the scientific world in general. This is generally on account of the unwillingness of industrial companies to allow their competitors to obtain any information which might be useful to them.

One obvious result of this policy is that it reduces the amount of scientific knowledge which is available. The free exchange of information is prevented, and there is a duplication of research work and a general slowing down of the progress of industry. Moreover, the quality of research is always lower the fewer and less qualified are its critics. A worker is inevitably less exact and scrupulous in a research which is written up for a probably unscientific board of directors than he would be if it were published in a technical journal; thus much so-called research carried out in industry and accepted as sound, would be more correctly appraised and acted upon if it were submitted to outside criticism through publication. On the other hand, the results of much excellent work never become known outside the particular company.

Another unfortunate effect is that the applied research worker obtains far less satisfaction from his work than his counterpart in the university, who is able to publish his results. The industrial worker realizes that his company regards his creative activity as being primarily directed towards the enrichment of shareholders, rather than towards the benefit of mankind in general. The objective of the industrial worker is thus inferior to that of the worker in pure science or medicine, and he may eventually react by treating his work merely as a means towards making a living.

The non-publication of research carried out by private enterprise seems to be far less pronounced in the United States than in Britain. In my view, the vigour and rapid progress of American technical industry can be ascribed very largely to the wealth of information which is available in the American literature of applied science. This volume of activity comes partly from the industrial research worker himself, and partly from university scientific workers who have become interested in the subject in question. The act of publication brings the most recent developments in industry to the notice of the academic worker and allows him to make his own contribution to the various problems which are opened up. There is thus a closer liaison between university and industry than has yet been achieved in Great Britain, where the two groups are often quite ignorant of developments in their respective fields.

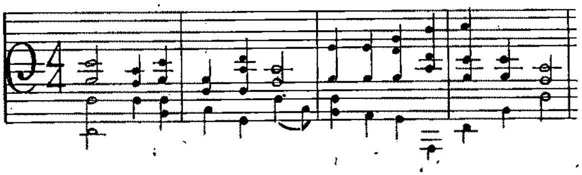
K. G. DENBIGH.

Simplification of Musical Notation

BY a slight modification of my suggested new stave[1], I have succeeded in still further increasing the ease of reading music. Following the precedent of the ancient division of the Great Stave of 11 lines, in which the middle *C* line was omitted, I suggest the omission in my new stave of the *two* lines denoting middle *C* sharp and *D* sharp and inserting these as leger lines whenever necessary. Further, to secure symmetry, the three bottom lines Bass *F* sharp to *A* sharp can also be omitted, and inserted as leger lines when required. The stave is thus reduced to 5 lines in each half—no more than in the standard notation.

The limitation of the "Bass Clef" is not likely to be found any disadvantage for two reasons: (1) The extended leger lines in sets of twos and threes present no difficulty in reading, even to the beginner; the readability of the system in this respect is another of its advantages over standard notation. (2) Examination of a wide variety of existing piano music, including hymn tunes, discloses that by far the majority of bass notes fall within the range *C* natural upwards, covered by the new curtailed stave.

Dr. Harrison's comments Nos. 4, 5 and 6[2] are most easily answered by the following example, showing four bars of Beethoven's Adagio in *B* major (5 sharps), from the "Emperor" Concerto:



The objection that this stave does not show key relationship is of diminishing importance in these days when many compositions are written 'without key', but it can obviously be met by simply stating the key above the stave wherever important key changes occur.

The above was written on August 8, but subsequently I have seen Lieut. Alan G. Smalley's letter in NATURE dated August 15. His ingenious suggestion of a 12-note stave having 6 equidistant lines and 6 spaces to the octave is fascinating, but the question whether it would be easier to read than my revised form of stave could only be settled by the 'controlled experiment' mentioned by Mr. Lloyd. Perhaps I may offer a few comments :

(1) My stave does not necessarily occupy more space. By arranging to give equal space to each semitone throughout the scale, that is, making the wider spaces one and a half times the others, the overall depth for an octave is the same as Lieut. Smalley's stave. This accurate spacing, in fact, is essential in order that all like intervals should be consistent in all keys.

(2) Experience has shown that more than five parallel equidistant lines usually become confusing to the eye, particularly in extended lengths, as on a page of music. I feel it would be difficult to read a series of chords rapidly on a six-line stave—one cannot easily avoid occasional confusion between lines 3 and 4. Also, I found a heavy line tended to catch the eye and distract attention from the music at times, so that it became a hindrance rather than a help.

(3) My stave, although primarily for keyboard music, is not unsuitable for other instruments. Since all 'naturals' are written on spaces and all sharps and flats are on lines, there is no uncertainty in reading, and in fact I find it easier to sing from than old notation.

Further, the stave obviously lends itself readily to the abolition of special clefs, since by placing the double lines above the triple lines, or vice versa, it can be made to represent any octave, with the C low or high on the stave, as desired. The 'pitch' of the stave could be easily indicated by a suitable conventional sign.

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[1] NATURE, 149, 640 (June 6, 1942).

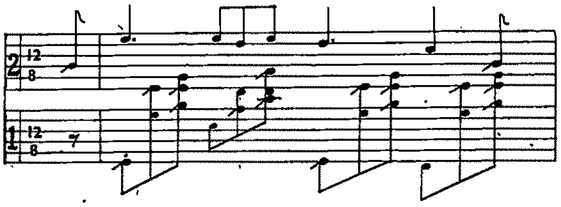
[2] NATURE, 149, 734 (June 27, 1942).

LORD BRABAZON'S appeal (NATURE, May 16, p. 554) for a simplified musical notation particularly interested me inasmuch as I have encountered all the difficulties he mentioned in learning to read music. Some time ago I developed what I considered to be an improved musical notation, but was discouraged from pursuing it by my wife, who is steeped in classical musical tradition. Lord Brabazon's comments were all I needed to get me to renew my efforts to systematize my notation.

It seems to me that the chief difficulties in the path of the musical novice arise from three causes. These are the dissimilarity of the bass and treble clefs; key signatures which, while they appear at the beginning of each bar, must be remembered thereafter; and notes written high above the treble clef, or far below the bass clef.

I propose a six-line clef, the bottom line to be *E*, and the top line the second A above it. Adjacent clefs will be separated by two spaces and a short line to be written in when the dividing *C* occurs. Instead of bass and treble signatures, the clefs will be numbered. The one which is obtained by adding a line to the bottom of the present bass clef will be 1, the one obtained by adding a line to the top of the present treble clef will be 2. The one below the bass will be the zero clef, and the one above the treble will be 3. These four clefs will more than cover a standard piano keyboard. The clefs are identical.

There will be no key signature, nor will the conventional sharp and flat signs be written in. A small tail affixed to a note will indicate an accidental. If it points up, the note is raised a semitone, if down, a flat is indicated. When the score runs above the 2-clef or below the 1-clef, the 3 or 0-clef will be written in for the required interval, and appropriately numbered.



I am submitting the opening measure of the Chopin Nocturne Opus 9, No. 2 in *E*-flat, written in the proposed notation. Inasmuch as this scheme compresses the space between the clefs, it is necessary to write notes to be played with either hand in either or both clefs. Differentiation is obtained by pointing the stems of notes to be played with the right hand up, those for the left hand down.

Brief experimentation with this notation has convinced me that it is simpler to learn than conventional music, and that sight reading is made many times easier. I have very little hope of its being adopted generally, however, for as Lord Brabazon pointed out, musicians are very jealous of their art, and seem to revel in its complexity.

W. E. INGERSON.

Bell Telephone Laboratories,
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July 15.

A Russian-English Technical Dictionary

IN connexion with Sir John Russell's letter in NATURE of July 11, on the subject of a Russian-English Technical Dictionary, workers in the plant sciences may like to know that a comprehensive glossary of Russian botanical terms, somewhat on the lines of Artschwager and Smiley's "Dictionary of Botanical Equivalents" (Baltimore, 1921), has been in process of compilation by us for the past two years, with a view to ultimate publication. While intended primarily to cover the field of descriptive or taxonomic botany, it will include also terms from as many other branches of the science as possible, besides a number of words of not strictly botanical application but of frequent occurrence in descriptive botanical works, for the benefit of those with little knowledge of Russian. An abridged copy, in the form of a card-index, will shortly be deposited at the Science Library, and additions will be made to it as the work of extraction proceeds.

The compilers would be glad to hear of any Russian botanical (especially non-taxonomic) works, available in Great Britain, likely to yield numerous, or unusual, technical terms.

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P. A. DATTAN.

9 Gloucester Court,
Kew Gardens,
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August 24.

CRYSTAL STRUCTURE OF OXYHÆMOGLOBIN

By M. F. PERUTZ

Cavendish Laboratory and Molteno Institute, Cambridge

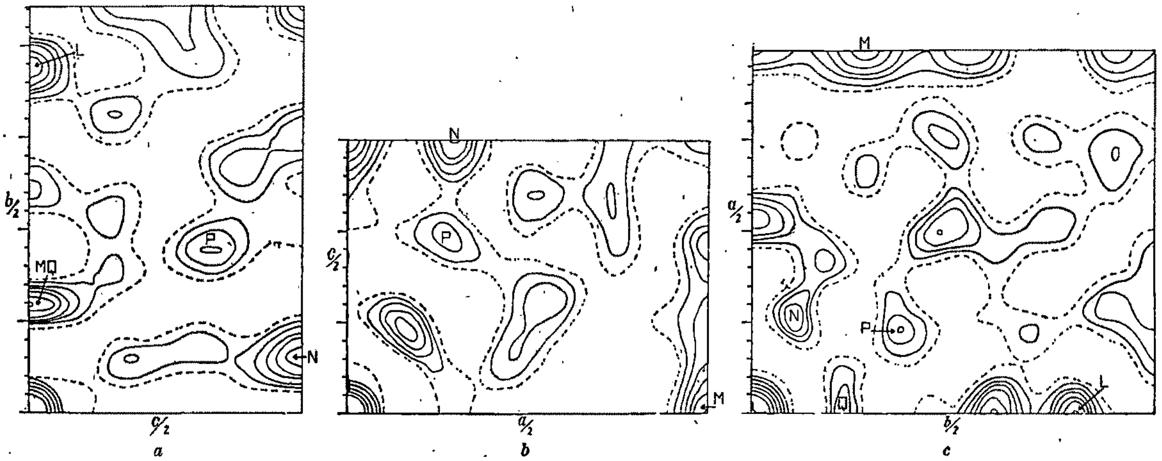
DR. E. F. HARTREE recently gave me a preparation of horse oxyhæmoglobin crystals which he had grown from 20 per cent alcoholic solution. It was found that these give good X-ray diffraction pictures both in the wet and the air-dried state, and that they promise to become an interesting subject for X-ray analysis. Though the present preliminary survey of the crystal structure has not led to any new information regarding the molecular architecture of oxyhæmoglobin, it has already given some useful hints about the way in which the molecules are arranged in the crystal.

It is well to compare the crystals of oxyhæmoglobin with those of methæmoglobin, on which work has now been in progress for some time[1,2,3]. Horse methæmoglobin crystals are monoclinic and exhibit strong birefringence and dichroism; there also exists a variety of oxyhæmoglobin crystals which is isomorphous with them and possesses the same optical properties[2,4]. It was surprising, therefore, to find the present crystals to be weakly birefringent, orthorhombic needles which appear almost isotropic when viewed along the needle axis and which show no trace of dichroism in any direction. While methæmoglobin crystals shrink visibly and violently on drying, no corresponding shrinkage of oxyhæmoglobin crystals could be detected under the microscope. On the other hand, drying affects their optical properties in an interesting manner; the optical character changes from negative to positive on drying and becomes negative again on rewetting.

Owing to the great instability of the wet crystals, all optical and X-ray measurements had to be carried out in a cold storage room at 2° C. (kindly put at my disposal by Prof. J. Gray at the Department of Zoology). Even so, the minimum exposure needed for one good X-ray photograph weakened the diffracting power of the crystals to such an extent that a second photograph from the same crystal showed only feeble blurred layer lines. In the circumstances it was not possible to determine more than the length of the needle axis, which is 64 A., as compared to 58·3 A. in the air-dried crystals. The latter are easier to handle as they are stable at room temperature and do not deteriorate much during exposure to X-rays. They give a sharp diffraction pattern with reflexions extending down to spacings of about 7–8 A. The cell dimensions are $a = 77{\cdot}6$ A., $b = 86{\cdot}8$ A., and $c = 58{\cdot}3$ A., giving a cell volume of 393,000 A³. The space group is $P\,2_1 2_1 2_1$, with four molecules in the unit cell.

The first step in the analysis of the structure of oxyhæmoglobin is to find the orientation of the four molecules with respect to the crystal axes. Now the orientation of the two hæmoglobins in the unit cell of methæmoglobin is known, and it was thought, therefore, that a clue might be found by comparing the 'vector maps' for the two different kinds of crystals. Accordingly, vector maps were prepared for the three principal crystal planes of oxyhæmoglobin (Fig. 1) and each map of this set was compared with each of the three maps which had previously been obtained from methæmoglobin. The comparison showed the peaks on the c projection of oxyhæmoglobin to be rather similar in position and shape to the peaks on the a projection of methæmoglobin, if the two projections are superimposed with the y axes in parallel. In Fig. 2 the central portions of the two projections are seen side by side, and in Fig. 3 they are superimposed. Only those parts of the two maps are shown which lie within a radius of about 20 A. from the origin, because only the intra-molecular peaks are significant for the present purpose. If we assume that there is no difference between the general molecular architecture of oxyhæmoglobin and methæmoglobin—an assumption which is reasonable both on chemical and crystallographic grounds—then the correspondence between the two maps indicates a similarity between the orientation of the hæmoglobin molecule with respect to the c plane in oxyhæmoglobin on the one hand and the a plane in methæmoglobin on the other.

The X-ray data on methæmoglobin lead us to believe that the hæmoglobin molecule is a platelet with a roughly elliptical base, that the axes of the ellipse are ∼ 48 A. and 64 A. and the thickness of the platelet is 36 A. (This view is based partly on pub-

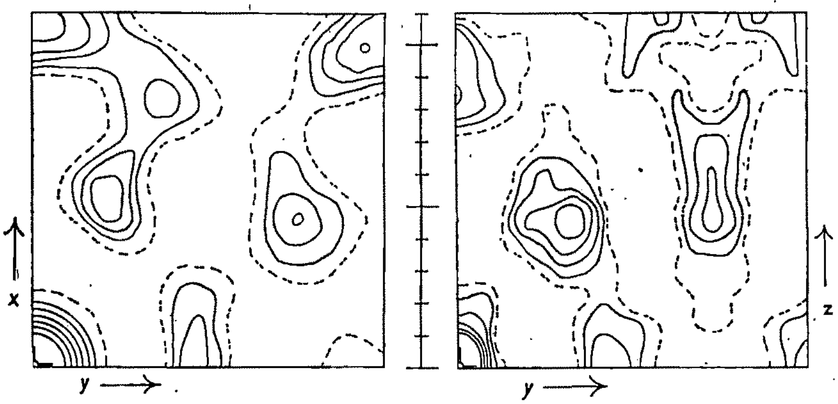


a b c

Fig. 1.

PATTERSON FOURIER PROJECTIONS OF AIR-DRIED OXYHÆMOGLOBIN. EACH PROJECTION SHOWS A QUARTER OF THE UNIT CELL. Contours are drawn at arbitrary intervals. The zero contours are dashed and negative contours omitted. The scales mark intervals of 2A. The origins are in the left-hand bottom corners.

lished data[3], partly on evidence which has come to light since.) For the purpose of describing the orientation of this platelet in the unit cell, the short and the long axes of the ellipse will be termed A and B, and an axis at right angles to the other two will be termed C. In methæmoglobin, A and B are known to lie parallel to the x and y axes respectively. The close correspondence between the two vector maps (Fig. 3) indicates that in oxyhæmoglobin B is parallel to y and C encloses an acute angle with x. The exact angle cannot be determined from the maps, because they merely show projections of the peaks the heights of which above the plane of projection are unknown. If the angle $C - x$ is, say, 30°, then the symmetry elements of the space group would require the angle to be $+ 30°$ for one pair of molecules in the unit cell and $- 30°$ for the other. Such an arrangement would account for the optical properties in a qualitative way: while in methæmoglobin the molecules all lie in line and the high birefringence and dichroism of the crystals give a true picture of the optical anisotropies of the individual hæmoglobin molecule, in oxyhæmoglobin the directions of maximum and minimum birefringence and optical absorption in the two pairs of molecules would be opposed in such a way as to compensate each other. The reversion of the sign of the birefringence on drying could be brought about by a slight change in the tilt of the molecule, namely, the angle $C - x$.



Oxyhæmoglobin Methæmoglobin

Fig. 2.

COMPARISON OF THE *c* PROJECTION OF OXYHÆMOGLOBIN WITH THE *a* PROJECTION OF METHÆMOGLOBIN. Only the central portions of the projections are shown. The Fourier summation for methæmoglobin was carried out by Dr. D. P. Riley, of Oxford.

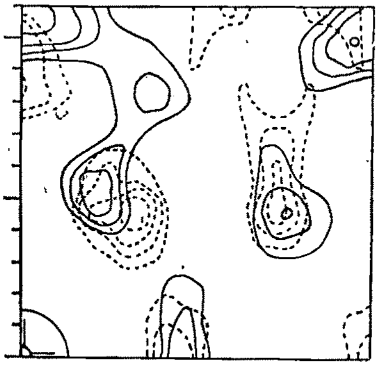


Fig. 3.

SUPERPOSITION OF THE TWO PROJECTIONS SHOWN IN FIG. 2.

The zero contours are now omitted: the full lines refer to oxyhæmoglobin and the dashed ones to methæmoglobin. In both Figs. 2 and 3 the scales mark intervals of 2 A.

The vector maps of oxyhæmoglobin are simpler in some respects than those of other proteins. Some, at least, of the peaks can be traced unambiguously in all three projections and co-ordinates assigned to them; they are marked L, M, N, etc., in Fig. 1. It is disappointing though that the maps do not provide any clues to the relative positions of the molecules in the cell. Knowledge of the three-dimensional vector structure might provide more evidence on this point. In the meantime, a structural model has been built up purely from considerations of packing, but further information is needed before it can be proved whether it is correct or not.

It is interesting to note that in dried crystals of oxyhæmoglobin, insulin[5] and chymotrypsin[2], reflexions are observed at spacings so low as 7 A., while in dried methæmoglobin[2] and lactoglobulin[6] that limit is 13 A. and 20 A. respectively. The degree of shrinkage on drying in the first group lies between 20 per cent and 30 per cent, whereas in the second it reaches 50 per cent. This shows clearly how the degree of perfection of the crystal depends on the violence of the shrinking process.

I wish to thank Dr. E. F. Hartree for providing me with the crystals, Dr. D. P. Riley for carrying out one of the Fourier summations, and Miss M. J. Boyes-Watson for preparing the drawings. I am greatly indebted to the Rockefeller Foundation for financing this research.

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[1] Bernal, J. D., Fankuchen, I., and Perutz, M. F., NATURE, **141**, 523 (1938).

[2] Perutz, M. F., NATURE, **143**, 731 (1939).

[3] Perutz, M. F., NATURE, **149**, 491 (1942).

[4] Reichert, E. T., and Brown, A. P., "The Crystallography of the Hemoglobins" (Washington, 1909).

[5] Crowfoot, D., *Proc. Roy. Soc.*, A, **164**, 580 (1938).

[6] Crowfoot, D., and Riley, D. P., NATURE, **141**, 521 (1938).

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, AUSTRALIA

ANNUAL REPORT

THE fifteenth annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia, covers the year ended June 30, 1941, and includes the financial statement as well as lists of publications of the Council and of the personnel of the Council and its committees and the committees concerning work in which the Council is co-operating.

A large part of the Council's activities is now devoted to the solution of problems arising out of the War, and to assistance and advice to various Government departments and other institutions and organizations which are concerned with that effort. This applies particularly to the National Standards Laboratory, the Aeronautical Research Laboratory, the Forest Products Laboratory and the Division of Industrial Chemistry. The reference to these activities is limited to brief general statements or omitted entirely.

Plant investigations have been concerned with native or naturalized plants as alternative sources of fibre, particularly as a substitute for jute, and investigations aimed at ascertaining the difference between the fibre from various Linum (flax) strains of good type are being continued. A survey is in progress to ascertain the position with regard to domestic supplies of vegetable and farm crop seed and methods of maintaining them. Weed investigations have shown that the St. John's wort can be virtually eliminated wherever subterranean clover can be grown successfully, but spraying with chemicals has failed to control an infestation of blackberry, and the work on both nutgrass (*Cyperus rotundus*) and mintweed (*Salvia reflexa*) has indicated that chemical sprays are of no value in controlling either plant. Field experiments on the control of take-all and the root-rot of wheat have continued at three sub-stations.

The work on the chemistry of tobacco at the University of Sydney was discontinued, as well as the study of disease resistance by the Section of Genetics. Work on the yellow dwarf disease, however, has continued actively, as well as investigations on smoking quality and physiological investigations. Fruit investigations have included an extension of the experiments on wax coatings for apples, and a reorganization to co-ordinate the wider attack on this problem organized by the Division of Food Preservation. A re-examination and summary of the results of the work carried out in Tasmania on the brown-heart problem during the last five years has been made. Extended co-operation with the Tasmanian Department of Agriculture in experiments, particularly in relation to the effect of different stocks and pruning technique on the keeping quality of apples, has also been a feature of the season.

Other investigations have been concerned with storage disorders and with fruit physiology in relation to keeping quality and seasonal climate. Work on pre-storage treatments to increase the cool- and common-storage capacity has now been greatly expanded. A survey is also in progress in coastal Queensland areas to locate indigenous or naturalized plants, which may be sources of certain drugs such as caffeine, ephedrine, cocaine, quinine substitutes and substances such as derris. Attention has also been given to potato virus diseases, particularly to virus X, and trials have been made on fungicidal dusts for the treatment of maize seed. The dusts had no perceptible effect on germination or vigour of early growth, except at Canberra, and then only when inferior or diseased seed was used.

Laboratory work of the Division of Economic Entomology on weevil control has been concentrated chiefly on a study of mineral dusts, and gratifying results have been obtained with one or two effective non-silicious dusts readily available in Australia. Milling tests with treated wheat indicated that the dust is removed in the ordinary mill treating process, although the dust treatment has certain disadvantages such as its effect on the appearance and free running properties of the grain. Although the Division does not possess the special equipment required for accurate assessment of the relative toxicity of fumigants, a series of experiments with simple apparatus has been carried out to determine the susceptibility to fumigants of Calandra and *Rhizopertha dominica* to such fumigants as di-β-chloroethyl ether, chloropicrin, ethyl formate, *o*-dichlorobenzene, carbon disulphide, ethylene dichloride and carbon tetrachloride. Results indicate that Rhizopertha is more susceptible to all these fumigants than either of the Calandra species. Practical fumigation tests of infested wheat in concrete silos have been carried out with ethyl bromide and with Cyanogas G, the latter appearing to give almost complete control of *Rhizopertha dominica*. The sterilization of stack sites and sheds with petroleum oil and tar oil emulsions indicates that only those emulsions containing *o*-dichlorobenzene and di-β-chloroethyl ether or their mixtures with creosote and oil have given consistently good results for killing the developmental stages of *C. granaria*, *C. oryzæ* and *R. dominica*, and good results have been obtained with emulsions of carbon disulphide or *o*-dichlorobenzene with crude naphthalene in the treatment of wheat shed floors when these are of loose earth in which infested grain may be buried.

In investigations on sheep blowfly, considerable progress has been made in compounding two useful dressings, the study of repellents and in an investigation of the breeding-ground of *Lucilia cuprina*, which is responsible for 90 per cent or more of strikes in Canberra. Toxicity studies using the contact toxicity technique indicate that 0·4 per cent of arsenious oxide is completely non-toxic to prepupæ when immersed for 30 minutes at 23° C., and αα-dipyrridyl is almost as high in toxicity as nicotine, dinitro-*o*-cyclohexyl-phenol and proflavine being only slightly toxic. Other entomological investigations have been concerned with the eradication of cattle ticks, insecticides for the control of wheat weevil and on the oriental peach moth. Animal health and nutrition investigations have covered pleuro-pneumonia of cattle, mastitis in dairy cattle, studies on phenothiazine as an anthelmintic, and blowfly problems and coast disease of sheep.

The Division of Forest Products Investigation has extended its work in the field of defence including the examination of numerous specifications for all kinds of defence and munition needs, the submission of advice on substitutes when necessary, and recommendations in regard to modified manufacturing methods or procedures; its work is claimed to have resulted in savings in imports, in the amount of timber used and in the use of timber of lower quality. Flax investigations have been enlarged and both chemical and engineering research in this field are now centred in the Division. The promising work on chemical retting is being revived and problems of scutching, tow treatment, drying of retted straw and control of dew retting are also being studied.

Food preservation investigations have covered problems in the preparation and transport of boneless frozen meat, chiefly for the use of fighting services overseas, canning problems, the use of *o*-phenyl-phenol in fillers to restrict bacterial waste in stored eggs, the storage of whole egg powder, the handling, treatment and storage of fruit, etc., investigations which will in future be co-ordinated by a special committee representing all bodies carrying out work in this field. Protective skin coatings for fruit have been investigated, particularly the preparation of colloidal wax emulsions that leave clear bright films on drying. Chemical treatments for the control of mould wastage in stored grains have also been investigated. Fisheries investigations have covered smoking of fish, fish liver oil production, and investigations on Australian tunas, pilchards, mullets, etc.

Brief reference is made to the work of the National Standards Laboratory, to aeronautical investigations at the Aeronautical Laboratory, which has now been given the status of a Division, and to investigations in industrial chemistry, including that on unshrinkable wool, on wool wax, utilization of minerals and on producer gas investigations, particularly the suitability of Australian hardwoods for the production of charcoal. Substantial progress has been made in building up a research organization and the development of research methods for dealing with lubrication, bearing and wear problems in Australia. The work is undertaken as co-operative research with the University of Melbourne and housed in the new chemistry school. The work of the Dairy Research Section has included a survey of the properties of Australian butter and the storage and transport of butter fat without refrigeration.

NORTH SYRIAN ARCHÆOLOGY AND OLD TESTAMENT SOURCES

THE July-August number of *Man* contains, among other interesting matter, a résumé of the most recent results obtained by Commander Schaeffer at his Ras Shamra dig. North Syria was a very important area geographically in prehistoric times, and the excavations at Ras Shamra, like those of Mersin in Cilicia, alas scarcely more than begun, may well prove to be some of the most interesting in the Near East.

The early story of Ras Shamra goes back into Neolithic times, and a peculiar dark, incised pottery has been found in the lowest level, which, at Mersin, occurs in a definitely Neolithic milieu associated with a splendid industry made in obsidian. But at a later date Ras Shamra was a Bronze Age Canaanite town of considerable importance and the capital of the kingdom of Ugarit, well known in Egypt, Babylonia and the Hittite empire. It was a meeting-place of Minoan, Mycenean, Babylonian and Anatolian cultures. Cuneiform texts have been unearthed which reveal the Canaanite mythology and were at any rate one of the sources drawn upon by the writers of the Old Testament.

The last (1938–39) of the ten seasons of pre-war work has considerably strengthened our knowledge in this respect, having enabled certain documents to be accurately dated; and it would now seem that many of the Patriarchal stories of the Old Testament were not mere oral tradition collected by authors of the time of Solomon and later, but were part of a written heritage derived from the Canaanite Bronze Age. Furthermore, it would appear that some of the religious and moral progress achieved farther south by the great Old Testament prophets had already started some centuries earlier in the mother-civilization of that Israelite culture which has meant so much to the world.

The latest work also unearthed the royal palace-fortress, which was protected by square towers of massive stone-work and in which were found the royal archives. The contents of the palace as a whole were very interesting and included a fine gold encrusted battle-axe with an iron blade belonging to the end of the fifteenth century B.C., as well as the muster roll of the army of Ugarit, naming the officers and men and the number of bows and slings handed over to them. The tale of dismantling, restoration and final destruction which the excavations unfold seems to show that this kingdom of Ugarit with its capital of Ras Shamra finally went under at the beginning of the twelfth century B.C. to those same northern sea-borne invaders who effected the ruin of Troy. All this new information we owe to Ras Shamra and the labours of Commander Schaeffer and his archæological and literary helpers.

M. C. Burkitt.

FEEDING AND BREEDING OF *CALANUS FINMARCHICUS*

THE importance of *Calanus finmarchicus* in the economics of the sea is so great that more attention has been paid to it than to any other copepod. That Dr. F. Gross and Mr. J. E. G. Raymont are now able to keep the adults for months under controlled conditions is a very definite advance on former work, and the two papers now before us are full of interest and suggestive observations[1].

Dr. Gross[2], in previous experiments, had made successful persistent cultures of many diatoms, using "Erdschreiber" as medium (a combination of nitrates, phosphates and soil extract) and had specialized in extending the method to minute flagellates. The present work on Calanus depends on its feeding on these cultures—both diatoms and flagellates—and its main importance lies in the fact that such food is found to be sufficient for the adults during their normal life-time. It is shown conclusively that for long periods Calanus can live entirely on a diatom diet, or one of diatoms and flagellates together, provided that there is a large amount of the food present, much more than under natural conditions in the sea. For a shorter period, they can live on flagellates alone. Nicholls[3], from field data, placed the life of an adult female at about six weeks. In Raymont's and Gross's large cultures of females, more than half the animals generally remained healthy for three to nine weeks, while a few were kept active for more than a hundred days. The maximum number of adult animals which could live successfully in 200 c.c. Erdschreiber medium, with excess of food and weekly change of medium, was approximately twenty. Adult males did not live so long as the females, and this is probably what takes place in Nature, as has already been suggested by Ruud[4]. The present experiments show that the females feed more actively than the males, the number of fæcal pellets being more than 2–10 times as great and the size of the pellets of the females greatly exceeding those of the males. The moulting of Stage V was found to be a critical stage when many specimens died.

The diatoms used included large and small species, the large Ditylium being specially useful. That *Calanus finmarchicus* is a mixed feeder in its natural surroundings is well known, and it has been shown by Lebour[5] and Marshall[6] that Crustacea remains are sometimes to be found in the gut contents. Marshall states that "a certain proportion of Calanus are always found eating crustaceans". She found that 7–48 per cent of the guts examined contained Crustacea, according to the season, and they were usually taken where there were few diatoms about. It is therefore important to know that Crustacea can be dispensed with. Lowndes[7] clearly shows that the varied movements of Calanus indicate different methods of feeding at different times and from the anatomy of the mouth parts that it should be able to catch and select food. Harvey[8] has made observations in this connexion from which it is probable that, while the small diatoms are filtered, the larger species are caught by the mouth parts. It appears that Calanus is able in this way to select its food and does not depend entirely on its filtering mechanism.

Crawshay (see Lebour[9]) reared Calanus in the Plymouth Laboratory through the whole of its life-history, feeding it on Nitzschia. Raymont and Gross reared it as far as the fourth naupliar stage only. It should be very easy, however, to continue the experiments on the present lines, and rear it through all its stages. They found that a constant temperature, 5°–12° C., is essential for all these experiments, but spawning was apparently less prolific; hatching and subsequent growth of the nauplii was poorer and moulting of the Stage V copepodite was less successful at the lower temperature.

The eggs swelled up enormously when released from the oviduct into the water, and they always fell to the bottom of the vessel. The second paper deals with the specific gravity of the eggs, nauplii, Stage V and adults, estimated from the rate of sinking of anæsthetized specimens in sea-water and solutions of different density of gum arabic in sea-water. The eggs are not buoyant but sink in sea-water at a rate of about 2·5 cm. per minute. The density of the eggs is almost the same as that of the nauplius and adults (male and female), but there is a surprising difference in Stage V, the specific gravity of which is only slightly higher than that of the sea-water used, namely, 1·0255–1·0265 (eggs 1·045–1·049, newly hatched nauplii and males and females 1·043–1·047). The authors suggest that the low density of Stage V and the consequent economic use of its fat reserves make this stage suited best for tiding the species over the winter months.

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[1] Raymont, J. E. G., and Gross, Dr. F., "On the Feeding and Breeding of *Calanus finmarchicus* under Laboratory Conditions", *Proc. Roy. Soc. Edin.*, B (Biology), **61**, Part III (No. 20), 267–87. 1*s.* 9*d.*; Gross, F., and Raymont, J. E. G., "The Specific Gravity of *Calanus finmarchicus*", ibid., (No. 21), 287–96 (1942). 9*d.*

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[3] Nicholls, A. G., *J. Mar. Biol. Assoc.*, **19**, 83–110 (1933).

[4] Ruud, J. T., *Cons. Perm. Int. Explor. Mer., Rapp. Proc. Verb.*, **56**, 1–84 (1929).

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[7] Lowndes, A. G., *Proc. Zool. Soc. London*, Part 3, 687–715 (1935).

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[9] Lebour, M. V., *J. Mar. Biol. Assoc.*, **11**, 1–16 (1916).

FORTHCOMING EVENTS

Wednesday, September 16

INSTITUTE OF MARINE ENGINEERS (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1), at 5.30 p.m.—Dr. S. F. Dorey: "Reduction Gearing for Marine Steam Turbines" (Parsons Memorial Lecture).

Friday, September 18

PHYSICAL SOCIETY (OPTICAL GROUP) (in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7), at 3 p.m.—Dr. C. R. Burch: (1) "Some Applications of the Optical See-saw Diagram"; (2) "The Evolution of a Reflecting Microscope Objective". Mr. J. L. Houghton: "Combinations of Spherical Lenses to replace Non-spherical Refracting Surfaces".

Saturday, September 19

INSTITUTE OF PHYSICS (JOINT MEETING OF THE MANCHESTER AND DISTRICT BRANCH AND THE INDUSTRIAL RADIOLOGY GROUP) (in the Physics Department of the University, Oxford Road, Manchester), at 2.30 p.m.—Dr. R. Jackson: "The Radiography of Heavy Metals".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE DEPARTMENT OF PHARMACY AND BIOLOGY—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (September 19).

LECTURER IN MECHANICAL ENGINEERING—The Clerk to the Governors, Mining and Technical School, Heanor, Derbyshire (September 21).

MALE TEACHER (GRADUATE) OF ENGINEERING MATHEMATICS AND SCIENCE at the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (September 21).

ASSISTANT IN AGRICULTURAL ECONOMICS SECTION OF THE DEPARTMENT OF AGRICULTURE, FOR FARM COSTS INVESTIGATION—The Registrar, The University, Leeds (September 21).

DIRECTOR OF THE CHEMICAL RESEARCH LABORATORY, TEDDINGTON—The Secretary, Central Register (Ref. F690), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2 (September 30).

LECTURER IN MECHANICAL ENGINEERING—The Director of Education, The Polytechnic, Regent Street, London, W.1.

CHIEF ENGINEER—The Secretary, Derby Gas Light and Coke Co., Gas Offices, Friar Gate, Derby.

BIOCHEMIST to work in the Department of Pathology under the direction of the Pathologist—The Pathologist, Royal Infirmary, Preston, Lancs.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Hull Bulletins of Marine Ecology. Edited by Dr. A. C. Hardy and Dr. C. E. Lucas. Nos. 9 and 10, Vol. 2: Continuous Plankton Records. Phytoplankton in the North Sea, 1938–39, Part 2: Dinoflagellates, Phaeocystis, etc., by Dr. C. E. Lucas; The Faeroe-Shetland Channel, 1939, by Dr. C. E. Lucas, N. B. Marshall and C. B. Rees. Pp. 47–94 + plates 39–62. (Hull: University College.) 8*s.* [218

Proceedings of the Royal Irish Academy. Vol. 48, Section A, No. 2: The Energy of the $1s2s\,^3S$ State of the Helium Atom and related Two-Electron Ions. By T. S. Wheeler. Pp. 43–54. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s.* [218

Freshwater Biological Association of the British Empire. Tenth Annual Report for the Year ending 31st March 1942. Pp. 40. (Ambleside: Freshwater Biological Association for the British Empire.) [248

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 11: The Biology and Natural Control of the Larch-shoot Moth, *Argyresthia laevigatella* H.-S. By Dr. Bryan P. Beirne. Pp. 130–149. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 2*s.* [248

Proceedings of the Royal Irish Academy. Vol. 48, Section C, No. 5: The Galway Fishery. By Arthur E. J. Went. Pp. 233–253. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 2*s.* [278

Geological Survey of England and Wales. Sheet 87: Barnsley. Scale of 1 inch to 1 Statute mile. Third edition. 28 in. × 23½ in. (Southampton: Ordnance Survey Office.) 2*s.* net. [278

Other Countries

Victorian Bush Nursing Association. 29th Annual Report and Statement of Accounts to 30th June 1940. Pp. 352. 30th Annual Report and Statement of Accounts to 30th June 1941. Pp. 119. (Melbourne: Victorian Bush Nursing Association.) [208

Commonwealth of Australia: Council for Scientific and Industrial Research. Division of Food Preservation and Transport, Circular No. 4-P: Notes on the Application of Refrigeration to the Australian Fishing Industry. Pp. 18. Pamphlet No. 111: The Biology and Cultivation of Oysters in Australia, 2: A Note on the Calcium Content of some East Australian Waters; 3: Biochemistry of the Proximate Constituents. By G. Humphrey. (Division of Fisheries, Report No. 7.) Pp. 40. (Melbourne: Government Printer.) [208

Smithsonian Institution. War Background Studies, No. 3: The Peoples of the Soviet Union. By Aleš Hrdlička. (Publication 3690.) Pp. ii + 29. (Washington, D.C.: Smithsonian Institution.) [218

Bulletin of the American Museum of Natural History. Vol. 79, Art. 6: Type Material of North American Microlepidoptera other than Aegeriidae in the American Museum of Natural History. By Alexander B. Klots. Pp. 391–424. (New York: American Museum of Natural History.) [218

Proceedings of the United States National Museum. Vol. 92, No. 3142: The Identity of some Marine Annelid Works in the United States National Museum. By Olga Hartman. Pp. 101–140. (Washington, D.C.: Government Printing Office.) [218

Uganda Protectorate. Annual Report of the Forest Department for the Year ending 31st December 1941. Pp. 8. (Entebbe: Government Printer.) 1*s.* [248

U.S. Department of Agriculture. Circular No. 635: Control of Insects attacking Stored Tobacco and Tobacco Products. By W. D. Reed and J. P. Vinzant. Pp. 40. Circular No. 647: Toxic and Repellant Sprays for the Control of Elm Bark Beetles. By R. R. Whitten. Pp. 12. (Washington, D.C.: Government Printing Office.) [268

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PUBLIC UTILITIES IN RECONSTRUCTION

THE eleventh report of the Select Committee on National Expenditure gives fresh pertinence to the discussion in the House of Lords on the extent, control and management of the essential public services, which Lord Reith initiated, and Mr. Bevin's speech to the National Chamber of Trade on July 15 also raised these important questions as to the exact relations between Government and industry and the nature and extent of State intervention. Whatever concern may be felt as to the capacity of the Civil Service in this respect, no report that has fairly faced the issues involved in reconstruction fails to recognize that some large measure of intervention will be necessary for a prolonged period after the War. That follows at once from the recognition that the Government must assume responsibility for creating the social and economic conditions in which our objectives of economic security, steady employment, greater equality of opportunity and distribution and a rising standard of living can be secured.

From the point of view of the relations between the State and industry, Government has two functions. The first, which is negative, is to act as referee between the various economic groups, to secure and maintain economic freedom and remove the present institutional defects—the tendency towards combinations in restraint of trade, the resistance to adaptation to new circumstances which nearly always develops from monopolistic practices, and the power of managers of industry to make decisions which may vitally and even adversely affect the interests of the community without being accountable to the community. This function probably involves revision of the patent laws. It certainly involves constant vigilance and control over monopolistic practices, a new code of industrial behaviour, some modification of the Companies Act, and more publicity from companies about their activities.

The second function of Government is positive and directive. It is that of ensuring that the whole community is properly fed, clothed and housed, and preventing the periodic recurrence of large-scale and demoralizing unemployment. In certain spheres it may involve the subordination of the profit motive to social incentive, though there should remain a vast area of industry and trade in which the fullest possible scope is given to enterprise and profit as the mainsprings of efficiency, adaptability and enterprise. The main problem is that of harmonizing the interests of the economic groups and those of the community, of reconciling freedom and security without losing the driving force of enterprise.

It is when we enter on the discussion of the evolution of the suitable technique of control that the main difficulties arise. No single formula is suitable for all purposes and for all forms of economic activity which it is desirable to control or supervise. Some activities or industries might be taken over entirely by Government. In this category fall certain public services and industries that have reached an advanced stage of development. For this the Post Office or the public corporation might serve as the model, and it was to this aspect that Lord Reith directed special attention in his speech in the House of Lords on June 17. Stressing the importance of giving the ideal of public service precedence over other factors such as political considerations and the profit motive, he emphasized the importance of efficient and disinterested administration and appeared to advocate a considerable extension of the public utility corporation. He suggested a National Transport Corporation covering railways, road transport, canals, coastwise shipping and internal air services, and urged that the railways should be brought under unified management and become part of the Corporation. In some measure central regulation and control are required in the building and civil engineering and building materials industries, both to settle prices and to secure economy in materials and machines, standardization, and the adoption of codes of practice and research.

Lord Reith would amalgamate the Central Electricity Board and the Electricity Commissioners, with the object of securing a uniform price for electricity over the whole of Great Britain. Gas and water, roads and river management, sewage and subsoil water are other services in which there are too many authorities and too many types of authority. While the duties and responsibilities of the public corporation system would be defined by the State in charter and statute, and Parliament would be consulted on policy, Lord Reith would give them the same freedom in organization and management as in commercial undertakings.

The nature and extent of the public services to pass under Government control may be the subject of debate. Lord Strabolgi was somewhat critical of Lord Reith's suggestions. He agreed that it is essential that our plans should be made known and accepted, and that we should plan for peace as we should have planned for war. So far as transport is concerned, his emphasis was laid on overseas transport, and civil aviation must also be included. He believes that all external transport should come under some measure of State control. Viscount Bledisloe also agreed that there must be very considerable control of transport and even in agricultural production for many years after the War; that, he said, need not imply or justify State ownership, and he stressed the importance of getting away from the party point of view and of being prepared to make sacrifices in our political outlook in order to obtain something like national unity and co-operative effort.

In spite of these differences of opinion as to the services to be controlled, there is widespread agreement as to the importance of leadership and of finding the men to carry the great responsibilities involved. Lord Strabolgi believes that the new aristocracy of leaders required will emerge from the War in young men and women who can be trusted to put public interest before the profit motive, and to manage these great undertakings efficiently. Lord Reith, however, thinks that our lack of institutions has prevented us from getting full value from the key men. Individualism is still required. Key men must be trusted, and governors and managers permitted to exercise their natural functions of governing and managing the corporations they serve, and to which and for which they are responsible. A planned society should be a free society, and it should and must be planned for freedom.

It is because the tradition of the Civil Service, with its caution, love of precedence and the Treasury methods of control with their emphasis on higher authority rather than on efficiency, does not encourage initiative or even a proper sense of responsibility in departments, that whatever form or technique is used for extending the measure of Government control, the day-to-day operation of the services and industries concerned should be entrusted to competent managers rather than to Civil servants. Lord Reith indeed suggested that Civil servants should not be concerned with the management of essential public services, and that the postal services, including telegraphs, telephones and wireless services, though now highly efficient, would be notably more so if they were not a Government department subject to Government methods of financial accounting and control, and that the same remark might apply to such other services as pensions and insurance.

The realization of this inherent weakness in the Civil servant lies behind the discussion which recently took place regarding the headship of the Civil Service, and reflects the criticism of Treasury methods of control and outlook contained in the Haldane report on the Machinery of Government, and discussed last year in a PEP broadsheet.

An illustration of the incapacity of a Government department in management matters is provided by the report of the Select Committee already mentioned. This inquiry into the working of the royal ordnance factories reveals clear signs of failure to plan with sufficient attention to securing a proper balance between the various parts. For example, in regard to filling capacity and the capacity for the manufacture of components, although at one factory 57 per cent of the floor space is at present lying idle, no record of the total amount of unused capacity is kept at the headquarters of the Ministry of Supply, and the Department was unable to make more than a rough guess at the total amount in all factories. Indeed, it was not considered the Department's business to know. Similarly, the redundancy of labour in factories affords evidence of failure to exercise sufficient forethought and to adapt actual arrangements to probable future developments. The discrepancies in the estimates of redundancy which exist between the headquarters officials and those actually in charge of factories indicate another aspect of faulty organization. The division of responsibility for royal ordnance factories, and the confused dispersal of responsibility for matters affecting the handling of labour tell the same tale of failure to recognize the importance of a clear appreciation of the proper functions of the various parts of the organization.

What is particularly disturbing is that the importance of matters of organization was specially stressed in the Select Committee's Seventh and Eighth Reports, which emphasized the necessity of replacing hasty improvisation by carefully balanced plans which ensure the best possible use of the limited resources of Great Britain. The need for the clear planning of programmes based on an accurate appreciation of existing factors and probable future developments was specially stressed. These warnings, like many of the habitual tools and techniques of modern industrial management, have been sadly disregarded in general and in detail.

On the organization side, neither at headquarters nor at the factory has the machinery been provided to integrate the responsibility for the various specialist functions and services. In the factories, effective control by the superintendent has been hampered by the encroachment of specialist authorities, a tendency encouraged also by the regional administration of filling factories. Functional control has been carried too far, and the recommendation for placing the control of all types of royal ordnance factories under one director-general is accompanied by the further recommendation for the transfer to him of all labour questions inherent in the management of the factories or administered by separate authorities. The deputy-director-general responsible for labour should not merely have full access to all relevant information, but should also be brought into consultation at every stage in all matters involving major questions of policy. He should not be concerned with those matters of labour supply, such as recruiting, which are the proper concern of the Ministry of Labour.

Of the twenty-four recommendations of this report, there is not one which would not be endorsed or adopted by industrial management as a matter of course, and some of them indicate a startling contrast between the practice and outlook of the Ministry and that of industry. The accumulation of stocks of materials and components to secure a proper flow of supplies; attention by the designing staffs to ease and economy in producing the completed product, and full testing from the production point of view of every design before acceptance; the application of statistical methods of control of manufacture to all suitable items of production; time and motion studies and the introduction of incentive bonus schemes; uniformity of methods and standards of inspection for the various products and factories; and the regular exchange of visits and of records and other documentary information between the superintendents of royal ordnance factories and the managers of private firms engaged on similar work—these, to take only a few points, are so much the accustomed practice in industry that it is astonishing that a Select Committee should find it necessary to make recommendations on such specific practices.

The significance of these details lies in the revelation they give of the extent to which the Civil Service has fallen behind industry in its use and knowledge of organization and scientific management. Insufficient liaison between design and production departments, for example, like the strictures in the report passed on the errors in siting and designing hostels due to insufficient regard for local information and for the desires of the workers, or like the failure to deal seriously with the problems of absenteeism, or the replacement of men by women, is primarily a reflection on management, and as such demands prompt action by the Minister of Production. The country is fast becoming impatient of a state of affairs in which continued neglect of informed, responsible and constructive criticism of the type which characterizes these reports of the Select Committee is possible.

This report undoubtedly adds great weight to that important volume of opinion voiced by Lord Reith, as well as, for example, by Mr. Samuel Courtauld in his article in the *Economic Journal* (Reprint, Macmillan and Co., Ltd. "Government and Industry: Their Future Relations", 1942, 6*d*. net), which is against direct Government control of industry, though the necessity for control is admitted. Whatever method of control is adopted—and there are other methods to be explored as well as that of the public corporation—it is essential that there shall be full control over the controllers on behalf of the community and to ensure efficiency. It may be sufficient in some particular services or industries to exercise control over general policy, with free play for private enterprise and the profit motive. Again, some essential services might be deliberately subsidized to make necessities available at a low price; or again, we might explore the possibility of nationalizing the costly equipment of certain industries, leaving their management in the hands of private enterprise.

Whatever method be adopted, there is no reason why Parliamentary control or criticism should be excluded, particularly on questions of policy, and any attempt to screen the public corporation from such control would be unwise. Equally, it is certain that the separation of day-to-day control of public services or industry from the Civil Service should not render the reform of the Civil Service less imperative or afford any pretext for shelving the attempt to bring a new outlook, greater flexibility and modern technique into the Service, while retaining the great traditions and great qualities which have justly won it the respect and admiration of the world.

On this point Mr. G. D. H. Cole has an interesting contribution in a recent issue of *Public Administration* (20, 1; 1942). Writing on reconstruction in the civil and municipal services, he considers that neither the national nor the local public services are likely to revert to their pre-war methods and traditions. The war-time changes have left too deep a mark, and large changes are desirable in view of the changing functions of national and local government and of the need for extensive readjustments in the very structure of the machinery of government.

Mr. Cole limits himself mainly to the personnel side, and urges that we must consider afresh the qualities we chiefly require in the public services of the future, and the methods of training, recruitment, promotion and movement within them which are most likely to bring these qualities to the fore. This involves, of course, some consideration of the relation between the public services and other types of professional employment, and particularly the relation between conditions in the semi-public services or public utility concerns and those in the public services or in private business. The twelfth report of the Select Committee on National Expenditure, although dealing particularly with two appointments in the Ministry of Works and Buildings, certainly raises doubts as to the soundness of the present practice. The conditions laid down by the Treasury to facilitate the appointment of able men who are expert in a special sphere are obviously open to abuse, and the dangers in wide disparity in the remuneration of the same type of work and ability by the State and in private industry should need no further emphasis.

The reform of the public services in this way is not exclusively a matter for those who control these services; it also concerns those whose task it is to shape the educational system in conformity with changing social needs. Thus Mr. Cole concludes that, next to plain honesty, the quality which the Civil Service will be called upon most to display in the work of reconstruction is adaptability. This is just the quality in which it is most lacking to-day. To remedy it, Mr. Cole suggests a greater diversity of experience, greater direct acquaintance with the things and persons affected for good or ill by the decisions of Civil servants, and a wider basis both for recruitment at varying ages and for promotion to the key positions of authority. He looks forward to a drastic overhauling of the municipal services, leading to much higher standards of recruitment and possibly to frequent interchange between the service of the local authority and the service of the State, thus enabling Civil servants in the departments affected to have periods of service away from the centre. A further advantage would be the gradual disappearance of the unfortunate sharp demarcation between the national and municipal Civil services.

Besides welcoming some disturbance of the excessive security and tranquility of the Civil Service, Mr. Cole maintains that the administrative qualities required for the highest offices are not to be found only among the higher non-technical administrators from whose ranks they are usually filled; he anticipates a large new infusion into both services of technical and professional elements, and the breaking down of the lines of demarcation between these elements and the ordinary administrative grades. This should be a natural result of the demand for the services of widely diverse types of specialists in reconstruction, as well as for the permanent expansion of the social services.

Measures such as these, which have been frequently advocated during the last decade, should do something to bring a more democratic, imaginative and adventurous spirit into the Civil Service than in the past. They inevitably involve some disturbance of the severely cloistered life which many Civil servants are accustomed to enjoy, and if at the same time there is exercised the power of compulsory retirement where a Civil servant has shown himself unfit for his post, a matter on which Mr. Cole, like the P E P broadsheet, lays great emphasis, there should be less difficulty in instilling and maintaining initiative and efficiency in a service which has deservedly earned for itself a world-wide reputation.

PHYSICS IN BIOLOGY

On Growth and Form

By Sir D'Arcy Wentworth Thompson. Revised and enlarged edition. Pp. viii+1116. (Cambridge: At the University Press, 1942.) 50*s*. net.

IT may seem sufficiently obvious that living tissue is to a large extent subject to physical and chemical laws; if a man falls off a cliff he is as much subject to gravity as a stone is, and the action of nitric acid or excessive heat on skin is much the same whether the skin is alive or dead. Sir D'Arcy Thompson's well-known work, now in its second edition, gives many illustrations that are less obvious. The author finds that at all stages of growth the mode and rate of formation of new tissue are largely determined by the form of the organism at the time; and since this in turn determines the rate and distribution of growth, the development is reducible to differential equations with regard to the time.

It would be impossible to give a summary of a book that is itself a summary, indicating prodigious learning. A few examples may, however, be given. There is a very promising attempt to reduce nuclear division to physical processes: the explanation of the forms of the septæ of Nautilus and of cell-walls in terms of surface tension looks complete. The formation of buds is attributed to a local concentration of potassium salts, which reduce the surface tension locally, and the surface is pushed out farther by internal pressure. The increased curvature increases the local adsorption of potassium, and we have an instability leading to a bud. But what determines the spacing of buds on the stem? Apparently, for less than a certain interval, the budless stem is stable, and it is not easy to see why. Such difficulties should lead to further investigation, and the attention of mathematical physicists might be directed to them. Fortunately, the author's language is not of the type common in biological writing, where about one noun in three may convey any meaning to a non-specialist. He does, however, sometimes use a physical term in a non-physical sense. For example, in discussing nuclear division he speaks of the importance of inertia (p. 309). On this scale inertia, as a physicist understands it, must be negligible in comparison with viscosity; and I cannot see what other meaning is intended. "Vector" is used in an unusual physical sense on p. 78.

It is a pity that in the discussion of energy relations in propulsion no reference is made to the fact that the square law of resistance only holds above a certain velocity depending on the size; below this velocity a linear law holds, and may be the right one for small organisms. It is not true, as stated on p. 31, that in an unstreamlined body the drag increases as the cube of the velocity; it is nearly as the square, but with a larger coefficient than for a streamlined body. On p. 43 it is stated that birds and aeroplanes are helped to fly by the compressibility of the air; this is not so, compressibility being practically irrelevant so long as the velocity is less than that of sound. With regard to the normal law of errors (p. 124), a correct statement would be that deviations equal to the standard error divide the area of the curve nearly in the ratios 1 : 4 : 1 and coincide exactly with the inflexions. In the allusion to the advantage of a long narrow wing in birds, explicit reference to the reduction of induced drag would be beneficial. An experiment is mentioned on p. 565 as providing a strong argument that general shrinkage does not account for the pattern of the earth's crust. This is surprising, because the irrelevance of the experiment was pointed out at once in the same journal; it was a case of elastic instability, which is easily produced on a laboratory or workshop scale. but not in the earth's crust as a whole. A rhumb-line on a sphere is not a great circle (p. 675).

It appears that the opinions propounded in the book have been regarded as antagonistic to natural selection and that the author acquiesces in that opinion. I do not see why. Surely it is possible that the more an organism can leave the physical and chemical processes to look after themselves, the better adapted it is to its environment. A machine is considered better the less frequently it needs special attention, and the same may be true of an organism. Mother Carey's "I can make things make themselves" may be the remark of a profound biologist. Also, if life is most efficient when most of its processes can be left to physics and chemistry, the difficulty of finding direct evidence for a specific 'life force' is explained on a vitalist theory and ceases to be an argument against it.

I think that most of this controversy arises from a failure to state the question properly. I quote from pp. 14–15. "Where physical science reaches its limitations physical science itself must help us to discover. Meanwhile, the appropriate and legitimate postulate of the physicist, in approaching the physical problems of the living body, is that with these physical phenomena no alien influence interferes. But the postulate, though it is certainly legitimate, and though it is the proper and necessary prelude to scientific inquiry, may some day be proven to be untrue; and its disproof will not be to the physicist's confusion, but will come as his reward." But what is discussed in this passage is not a postulate at all, but a considered proposition. If we assert that no alien influence interferes, we assert that this statement will never be proved untrue, and there is no occasion to discuss what will happen if it is. If we assert that some other influence does interfere, and make use of the statement that none does, we contradict ourselves at every turn. It is precisely because we neither assert nor deny the proposition that there is any need to investigate. But a postulate must be an asserted proposition. A considered proposition, however, is simply one possible answer to a question, in this case that physics can account for all the phenomena. The scientific urge comes from considered propositions and is hindered, if not destroyed, if they are prematurely asserted. The paradoxical conclusion of the above quotation is, in fact, the result of a verbal confusion, which is none the less dangerous for being a common one.

Further, I have followed the distinguished author in assuming that we do know what we mean by "living". But do we? We may agree that a flying swallow is living and that a stone is not; but have we any empirical criterion that we can apply in every instance? Without one the proposition enunciated is not even intelligible.

Again, Sir D'Arcy says (p. 650) that it does not help us to say that molecular asymmetry may have originated in fortuity. But there is a close enough resemblance between the earth and Venus for us to suppose that life could have developed on Venus; and recent work makes us confident that it has not done so. I think that it does help us to say that an extremely rare event happened once on the earth and never happened on Venus. In any event, though anybody making a living organism in the laboratory would probably get a Nobel Prize, we are warned against suggesting it as a problem to a Ph.D. student.

It is superfluous to recommend the book to biologists, who will know enough about the first edition; to them the reviewer need only say that abundant attention has been given to later work. But mathematical and experimental physicists will find in it, at the least, extremely interesting reading, and some of them, one may hope, suggestions that will repay further research.

HAROLD JEFFREYS.

MEASUREMENT OF TREES

Measurement of Trees
By Reginald Davey. Pp. 236. (Nutley, Sussex: The Forest Press, 1942.) 21*s*.

IN his book, Mr. R. Davey tells us that the work is the outcome of three years research into British commercial methods. "It is", he says, "the first systematic study of the ocular system of measuring growing trees." His laudable object was a simplification of methods of measuring trees and woods for sale, "so that the exercise of care can secure results at present attainable only after years of practice". One of the chief objects of the research work was the much-vexed question of 'taper' in the bole.

Officers of the Forestry Commission have undertaken a considerable amount of investigation into this matter in the case of conifers. With regard to hardwoods, there should be no quarrel with the author's work, statistical tables, and views, if it is understood clearly that they are drawn up for present conditions and existing woods in Great Britain, where true forest management and sylviculture, with few exceptions, have been admittedly absent. Consequently, as a general rule, the boles of the trees in a wood develop a taper which it is the object of good sylvicultural treatment to reduce to a minimum. Nature, in the natural forests of the world, as a result of considerable profusion and waste and long periods of time, produces the final product in a bole resembling more and more the cylinder, between the base of the stem and the point at which the main branches take off. This is a common sight in the tropical forest. The same is observable in the coniferous belt in northern Europe. Moreover, in the case of some of the well-managed oak and beech forests in France, worked on rotations of 180–200 years, the bole, that is, the merchantable timber part of the tree in which the author is interested, is far nearer the cylinder than the cone or paraboloid, and does not resemble the diagrams in his Fig. 1. Moreover, the buttress or 'root-swelling' in the case of these latter is restricted and has little resemblance to the author's neiloid—so much so that the French practice is to dig a small trench and expose the basal parts of the root system and fell the tree by severing the roots near their junction with the stem.

In a book based on research work which should have a considerable value in Great Britain it appears that the above points should be placed in their proper perspective, a perspective which emphasizes perhaps the value for Britain of the work, in view of remarks such as the following. Mr. Davey writes: "Trees rarely resemble either cone, paraboloid or neiloid for their whole length." If by 'whole length' the author implies timber length to the main branching, even in the case of conifers it is evident that he has never seen a great deodar (*Cedrus deodara*) standing in the forests of the north-west Himalaya. Again we read: "Owing to heavy branching there is less uniformity in the stems of hardwoods . . . the branches are seen to be larger in proportion to the stem, set on the stem less evenly and generally to affect the shape of the stem for a greater part of the length." While this description probably applies to 90 per cent or more of the hardwoods grown in Great Britain, it would not be accepted by anyone who has seen an old teak, s'al, deodar or mahogany tree in a fine piece of virgin forest, or oak in well-managed long rotation forests in France. The book is well illustrated with plates and text-figures, and its get-up, in these days, is a credit to publisher and printer. E. P. S.

SOCIAL GEOGRAPHY IN INDIA

Man and his Habitation

A Study in Social Ecology. By Prof. Radhakamal Mukerjee. (Lucknow University Studies, No. 12.) Pp. xv+313. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1940.) 8*s*. 6*d*. net.

THE relations of man and society are a prominent subject of contemporary discussion. Traditional links everywhere are weakening and new experiments are to the fore. In many books we read discussions that, often unconsciously, presuppose a European or North American background; but, in this case, the background is Indian and the differences in facts adduced as well as in lines of argument make a reader wonder whether there is really such a subject as social science or whether there are not rather numerous 'social geographies' to be studied.

The author thinks that it is useful to study society, in its relation with habitation, under three heads, namely, density (of population, of dwellings, of groups, and so on); mobility (including mobility of status as well as mobility of persons and of groups and their habitations); and distance (including here contrasts of status as well as distance in the physical sense). Density, mobility and distances are thus to be studied with special reference to their social and institutional implications. All through his book the author is specially concerned with the contrasted implications of urban and rural life, particularly in India, but also in the United States and, to some extent, in Europe.

Relatively high density, quick mobility and sharp social division or distance are considered to be features of urbanization under which human relations tend to become transitory, segmental and superficial, regulated by more or less rationalized contractual arrangements; whereas a lower density, a much slower change and a closely graded hierarchy taking more account of personal skill and worth are, for him, features of rural life. He nevertheless sees that there is an up and down movement of caste groups, yet not a sufficiently rapid change to upset the solidarity of the village. The thought behind this is essentially that expressed by Sir Henry Maine in his view of the gradation from status to contract and from kinship to neighbourhood. While Mukerjee expatiates on the evils of urbanism, he sees also the weak side of Indian village life—the tenacious conservatism, the unthriftiness in land-use, fright and ill-treatment in the hands of money-lender and landlord, and wide dominance of superstitions that the rationalizing processes of urban life may later on too easily transform into a subservience to mass emotion.

Sometimes the author seems to continue the old error of so many writers on social subjects in supposing that a nomadic pastoral stage of society intervened between the earlier one of hunting and collecting and the later one of food production by cultivation. All the indications we have, admittedly still insufficient, go to show that from hunting, mainly by the men, and collecting, mainly by women and children, society often graded to cultivation (by the women and later by the enslaved men of conquered or client groups). Herding may have arisen in different ways in different cases, but seems more often to have developed as an accessory to cultivation rather than as a preliminary to it. The communities that depend almost entirely on flocks and herds are usually highly specialized ones, though cases are known in which they have become transformed, usually under external pressure, into cultivators. If Mukerjee does tend to put pastoralism before cultivation sometimes, he, at any rate, sees it is associated with certain environments unfavourable to cultivation because of upland positions, drought, etc.

He has a good deal to say concerning the boys' dormitory, with sometimes another for the girls; and his section on the early evolution of habitation in India in its relation to forest clearing by fire for shifting cultivation gives an interesting sequence that emphasizes the great and widespread importance of the aboriginal, if to some extent Hinduized, elements in Indian life. The village dormitory for boys, the houses of the advance guard, housing of a slightly better type for the headman and his kinship group and in due course for the ceremonial leaders in process of evolution towards a priesthood, as well as the menstruation hut are all reviewed. A place in a grove may become the centre of ceremony, but the temple may also arise from a house under which burials have taken place and whence ancestral spirits may come into the women for rebirth. An unpartitioned communal hut may be an alternative, or even a still earlier, feature. There are people such as the Kabuis in Manipur who hold on to one and the same village site and yet shift their area of cultivation year by year in a set rotation. Houses come to be arranged around a dancing floor, and separate quarters of the village are differentiated for diverse kinship groups, with the unkempt hangers-on relegated to an outlying patch as untouchables. One may note for comparison the gipsy quarters appended to many east-central European villages and some of the "little Londons" hanging on to small English towns.

Mukerjee has much to say concerning the Panchayat, which, on the whole, he tends to idealize and wants to see revived in towns as well as villages. The Panchayat may be an assembly of elders of a village or a caste-group in a large village, and it has in the author's opinion checked the alliance of urban and rural capitalism which he seems to fear as an agreement between kites and crows at the expense of sparrows. In some of his reflections on Europe there is a tendency to ascribe to capitalism changes that have come largely through the use of root crops.

From different chapters one gets interesting hints as to diversities between different provinces and regions in India, and the whole book leaves one with a sense of the vitality of the Indian villages and a wish that the author had given us a book on India and had foregone rather less profitable general sociological surveys, though his knowledge of countries outside India compares more than favourably with the knowledge of some noted European writers concerning peoples outside Europe. Mukerjee's book is inspired by the hope of a planned economy in which durability of relationship will once more increase, and intimate touch with the land and personal loyalties shall have their chance.

H. J. FLEURE.

A PROBLEM IN ECONOMETRICS

The Analysis of Economic Time Series

By Harold T. Davis. (Cowles Commission for Research in Economics, Monograph No. 6.) Pp. xv+620. (Bloomington, Ind.: The Principia Press, Inc.; London: Williams and Norgate, Ltd., 1941.) 5 dollars.

ECONOMETRICS may be described as the application of mathematics to statistics for the elucidation of economic forces and the measurement of their effects. Since these actions are dynamic the principal data are successive records in time, or time series, and in recent years many mathematical economists have made them the subject of intensive study. Mr. Harold T. Davis has brought together and criticized the theories and methods employed in this region, and illustrated them with a wealth of new material. His summary of his subject is (p. 59): "The problem of single time series is concerned with three things: first, the determination of a trend; second, the discovery and interpretation of cyclical movements in the residuals; third, the determination of the magnitude of the erratic element in the data. This preliminary problem, once solved, leads immediately into the more complex one of discovering valid interactions of one time series with another. Upon the discovery of such relationships the hope of establishing a firm science of economics inevitably rests. From them will come ultimately the power of prediction, which is the final test of any mature science."

The Trend. If there are causes of a permanent or organic nature that affect the whole series, we may expect that their effects can be expressed by mathematical formulæ, or by some smoothing process. Thus a straight line, parabola or polynomial, applied to the terms or their successive ratios, may give a general picture of the movement over a long period, and leave residuals the algebraic averages of which over short periods are zero. Continual growth, as of population or production, may require an exponential expression, usually with a damping term; that most used is the 'logistic', the equation of which is $\frac{dy}{dt} = \frac{y}{a}\left(1 - \frac{y}{L}\right)$. In the author's opinion such curves can be successful only if they are based on some a priori theory. Failing any successful choice of an equation, the alternative is the device of the moving average, or some other arithmetical method of smoothing.

Cyclical movements. The mathematician naturally turns to harmonic analysis to determine the existence of, and to measure, regular periodic movements, and Mr. Davis devotes a great deal of his book to the nature and use of the periodogram and to the periods indicated by it in a number of selected series. The periods most generally found are seasonal, which require no logical explanation, and the 'trade cycle' for the genesis of which many ingenious theories are considered in Chapter 8. There is also a persistent 40-months cycle in stock exchange and allied series, for which no cause has been assigned. It is a weakness of harmonic analysis as applied to economic series, that it can reveal only waves of uniform length, whereas the length of the trade cycle has perhaps varied from seven to eleven years during the past hundred years; if the effect of a nine-year period is removed, new and irregular residuals are introduced.

Residuals. The effect of the removal of the trend and cyclical movements is measured by the reduction of the 'variance' of the series. Thus, if s is the original standard deviation, we may write

$$s^2 = s_t^2 + s_h^2 + s_v^2,$$

where s_t, s_h, s_v are the standard deviations attributable to the trend, the harmonics and the residuals respectively. The relative sizes of these squares are taken as measuring the 'energy' of the three factors. The residuals, though free from systematic movements, may nevertheless have some structure; as for example, an increase may be followed by a further increase more often than by a decrease, and autocorrelation (correlation between one term and a later term) may be present. The author devotes an interesting chapter to the study of random series, with reference also to the possibility of forecasting movements when there is autocorrelation. But perhaps the main importance of s_v is as a measurement of the magnitude of the variation that may be expected from unassignable causes. The behaviour of a series as regards trend, cycle and nature of the residual is clearly an important subject of observation; but study of the relationship between two or more series is more fundamental for econometrics. For this purpose the correlation of the residuals, x_t and y_{t+s}, from two series is computed for various values of s, the number of terms lagged (s zero is itself important). The usual process, followed by Mr. Davis, is to compute the correlation coefficient for several values of s, and select the maximum; thus we have the following coefficients between stock-market quotations (the Dow-Jones averages) and pig-iron production (s in months)

s	r	s	r	s	r
− 12	− 0·182	− 3	0·166	+ 6	0·568
− 9	− 0·130	0	0·515	+ 9	0·369
− 6	− 0·036	+ 3	0·684	+ 12	0·130

From this, Mr. Davis's conclusion (p. 105) is: "This means that pig-iron production follows by three months the industrial averages", and later (p. 235), this becomes, "It was established that pig-iron production moves three months after the stock price averages". Surely this is too strong a statement; the correlation coefficient is only an average, only one of several possible averages; a relationship is no doubt shown, but action based on it would by no means always be successful.

Space does not permit even allusion to all of the many topics discussed, or criticism of the less mathematical chapters on wealth and other economic subjects, which are less guarded than the purely analytical studies. Parts of the book are very difficult reading, and only possible to a qualified mathematician, who should be prepared to refer to the originals of studies where results are only summarized. The whole is a very valuable account of the work that has already been done in this important region, while at the same time many indications are given of promising lines of approach towards the basing of some parts of economic theory on a quantitative basis.

A. L. BOWLEY.

CATALYSED POLYMERIZATION OF METHYL METHACRYLATE IN THE LIQUID PHASE

By PROF. R. G. W. NORRISH, F.R.S.,
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USING benzoyl peroxide as catalyst, Norrish and Brookman[1] found that the order of the polymerization reaction of undiluted methyl methacrylate is approximately zero in the first stages; the initial rate of reaction is proportional to the square root of the catalyst concentration[2]. The rate of reaction was found to rise markedly after about 10–20 per cent polymerization, and at the same time considerable heating of the system took place. Norrish and Brookman supposed that the temperature rise caused the rate increase, the former arising from a decrease of thermal convection in the system with increasing viscosity during polymerization. After experiments on catalysed and uncatalysed reactions, Schulz and Blaschke[3] took the opposite view, namely, that the rate increase mainly caused the temperature rise, and supposed that the former was due to an increase in the rate of initiation of active centres.

In order to test these two views, we polymerized methyl methacrylate slowly in narrow glass tubes (4–5 mm. internal diameter) at 60°, 40° and 25° C., using less than about 1 mol. per cent of benzoyl peroxide. The extent of reaction was measured dilatometrically up to about 40–50 per cent change. Under these conditions, we found that the rate of polymerization was nearly steady in the initial stages (up to 12–26 per cent polymerization, depending on the temperature and catalyst concentration), yet afterwards quickened to about 5–10 times the earlier rate, despite the fact that the maximum temperature in each tube rarely rose more than 1° C. from the thermostat reading in any of our experiments. It is thus evident that much of the change in velocity is not due to temperature rise, but further observation led us to question whether it was due to an increase in the rate of initiation of centres as suggested by Schulz and Blaschke.

In view of analogies in the kinetics, it seems reasonable to accept for methyl methacrylate a theory of polymerization similar to that substantiated by Schulz[4] for styrene. Thus, if C is the catalyst concentration, M the monomer concentration, and n the concentration of active centres, the rate of initiation of chains is given by k_1C, the rate of propagation by k_2nM, and the rate of termination by k_3n^2. This gives the steady rate of polymerization as $-dM/dt = k_2k_1^{\frac{1}{2}}k_3^{-\frac{1}{2}}MC^{\frac{1}{2}}$. If an increase in the rate of initiation (k_1C) is responsible for the rise in rate of polymerization of methyl methacrylate, then the chain-length of polymer should fall throughout reaction, for the average chain-length is given by $\overline{P} = k_2k_1^{-\frac{1}{2}}k_3^{-\frac{1}{2}}MC^{-\frac{1}{2}}$. In Schulz's data there is no evidence of such a fall during the period of increase of rate, notwithstanding considerable temperature increases; furthermore, in all our experiments (under practically isothermal conditions) we have invariably found an *increase* of chain-length of polymer throughout this period, even at 25° C. and 40° C., where catalyst decomposition must be inappreciable. A few typical results are given in Tables 1 and 2, illustrating our findings. In Table 1, $\overline{P}$ is an index of chain-length of polymer, being the linear extrapolation to zero concentration of the expression: (spec. viscosity in acetone / conc. of polymer, base mols. per litre).

TABLE 1. POLYMERIZATION OF UNDILUTED METHYL METHACRYLATE. TEMP. 25° C. 0·410 MOL. PER CENT Bz_2O_2. RATE APPROX. STEADY UP TO 12 PER CENT POLYMERIZATION.

Time (min.)	33	1238	2167	2255	2350	2548	2587
% Polymerization	0·3	12·0	—	33·1	37·5	—	47
Approx. rate polym., %/1000 min.	10	11	24	32	44	66	70
$\overline{P}$	—	15·6	17·6	—	19·8	20·3	—
Tube temp.	25·0	—	—	25·0	—	—	25·1

In Table 2 the square root law is illustrated, and it can be seen that the rise in rate was found to occur latest in the polymerization with the highest catalyst concentration.

TABLE 2. POLYMERIZATION OF UNDILUTED METHYL METHACRYLATE TEMP. 60° C.

Mol. % Bz_2O_2	Initial rate polym. %/min.	$\frac{\text{Init. rate}}{\sqrt{\text{Catalyst conc.}}}$	% polym. at start of rise in rate
0·0261	0·07	0·43	14
0·0950	0·14	0·45	16
0·412	0·28	0·44	21
0·775	0·37	0·42	26

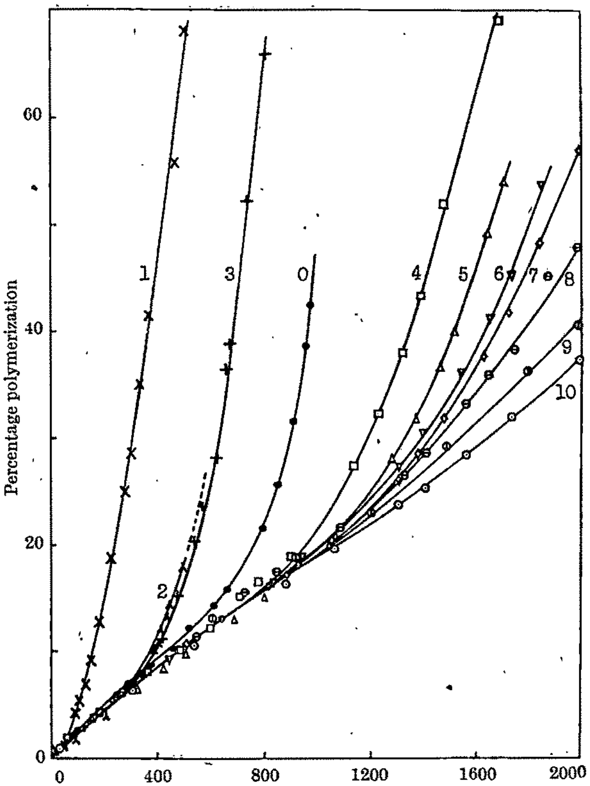
Further, with the same catalyst concentration, we found that higher temperature also caused a later rise. High catalyst and temperature are conditions for producing a low bulk viscosity of the polymerizing system for a given percentage reaction. This fact, together with our observations on the rise of chain-length throughout polymerization, suggested to us that increasing bulk viscosity is indeed essentially responsible for the rise in rate and chain-length, in that it decreases the rate 'constant' of termination k_3. For if k_3 decreases throughout polymerization, the rate and the chain-length will both rise. In this connexion Gee[5] has referred to the possibility of k_3 decreasing throughout polymerization.

As a critical experiment we polymerized methyl methacrylate at 40° C. with 0·0094 mol. Bz_2O_2 per litre in the presence of a series of diluents (see Fig. 1) each 40 per cent by volume. The diluents were chosen from good and poor solvents and also precipitants of polymethyl methacrylate, so that the bulk viscosity of each system at a given percentage polymerization would differ as greatly as possible. In order to obtain a measure of the extent of this variation in bulk viscosity, preparations were made, each of 0·93 gm. per cent, of a certain sample of polymethyl methacrylate in a mixture of 2 c.c. of monomeric methyl methacrylate and 2 c.c. of diluent (a small amount of hydroquinone was added to prevent further polymerization). Table 3 shows that the bulk viscosities were very different according to the nature of the diluent.

TABLE 3.

No. of diluent in Fig. 1	Nature of diluents	Bulk viscosity of preparation
1–3	precipitants	firm gel separating from clear liquid
4–7	poor solvents	thick sol or light gel
8–10	good solvents	thin sol

The accompanying graph summarizes the changes which took place during the polymerization of the various solutions of methyl methacrylate. None of the diluents was specially purified, and short induction periods were observed before polymerization started, presumably due to small amounts of inhibitor; the recorded curves are plotted from the end of each induction period. It will be seen that up to a certain stage in each experiment, the influence of all diluents was similar, but beyond this stage, the rate of reaction rose in a specific manner, in agreement with our views that with a poorer solvent and therefore greater degree of aggregation of polymer chains, the rise in rate should be more marked and occur earlier.



POLYMERIZATION OF DILUTED METHYL METHACRYLATE 40° C. 40% DILUENT (BY VOL.). 0·0094 MOL.Bz_2O_2/LITRE.

0, Undiluted monomer.
1, 2, 3, Precipitants of polymer: 1, butyl stearate; 2, heptane; 3, cyclohexane.
4, 5, 6, 7, Poor solvents of polymer: 4, amyl acetate; 5, *n*-amyl chloride; 6, ethyl acetate; 7, carbon tetrachloride.
8, 9, 10, Good solvents of polymer: 8, benzene; 9, chloroform; 10, methylene dichloride.

In our experiments with each diluent* we precipitated two samples of polymer: one during the initial period of slower reaction and the other after the rate of reaction had increased. In Table 4*a* values of the viscosity index of chain-length, $\bar{P}$, are given for the former period, and in Table 4*b*, for the latter.

A comparison of the two values for each diluent shows that the most marked increases of chain-length occurred for the poorest solvents, and scarcely any at all occurred for the best solvents; referring to the graph it can be seen that the poorest solvents gave the most marked rise in rate and the best solvents scarcely any at all. This parallelism between increase in chain-length and rate of reaction is exactly what we should expect, assuming the termination 'constant' k_3 to decrease with increasing bulk viscosity of the system.

TABLE 4*a*.

Diluent	Precipitants			Poor solvents				Good solvents		
Nos. (see graph)	1	2	3	4	5	6	7	8	9	10
% Polym.	–	4	13	10	13	12	12	13	12	12
$\bar{P}$.	–	13	18	12	13	13	12	13	10	12

TABLE 4*b*

% Polym.	71	15	62	70	55	55	62	52	35	38
$\bar{P}$	34	20	38	25	21	19	17	15	12	12

With diluents 1–3, the polymer precipitated as an opaque gel almost at the start of reaction, whereas with the other diluents, precipitation never occurred. We suppose that forces between polymer chains tend to produce association, while forces between solvent and chains act oppositely according to the solvent 'power'; thus, chain association can occur in a single-phase system or in an opaque gel according to diluent, causing a reduction of mobility of the active growing ends and therefore a fall in the rate of termination of chain growth.

It seems likely that variation of the rate 'constant' of mutual termination throughout polymerization is not confined to methyl methacrylate, though for this substance the effect may be particularly strong since there is probably little opportunity for kinking of the macromolecules[6], and thus the mobility of the growing ends of polymer chains may be more sensitive to constraints applied at remote parts. In the literature there are several instances reported of high rates of polymerization and chain-lengths, for example, with polyisobutene at low temperatures[7] and in some emulsion polymerizations[8], and it is possible that explanations may apply on the lines we have put forward. We ourselves have (incomplete) data suggesting that similar effects may occur to a lesser degree with vinyl acetate and styrene.

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* It should be recorded that, in our experiments with diluents 4–10, about 1 per cent of polymer was present at the start. In order to minimize inhibiting effects of oxygen, reaction tubes were sealed, and monomer was kept *in vacuo*; at room temperature the monomer polymerized slowly.

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ILLUMINATION AND VISUAL RANGE UNDER WATER

By DR. H. H. POOLE
Royal Dublin Society

IN a paper on illumination and visual range under water[1], R. Ruedy has given an account of measurements made with rectifier, or blocking-layer, photocells by some American and European workers during recent years, including particularly a summary of the important work done by Utterback and his co-workers in eastern Pacific waters, and by Clarke and his colleagues in the western Atlantic, and a useful bibliography which, however, does not include an important paper by Le Grand[2] or a paper by Atkins and Poole[3].

He has also attempted the rather difficult task of correlating the results so obtained with the visual observations recorded by divers, and given some account of photometric measurements made in Beebe's bathysphere, and of underwater photography.

In comparing the results obtained by different workers it is essential to consider the instrumental conditions under which they are obtained. It is always necessary that the cell should be enclosed in a water-tight case behind a strong window, which is generally horizontal so as to eliminate troubles due to the rotation of the photometer, and is turned upwards so as to measure the vertical downward illumination. Most workers nowadays place a diffusing glass above the window, so that the photometer may measure the light from a complete hemisphere falling on a horizontal surface; but this has not always been done, and without the diffusing glass the photometer, when submerged, is only sensitive to rays making an angle not exceeding 48° with the normal to the surface. This may, in certain circumstances, have an appreciable effect on the ratio of the illuminations recorded at different levels, and will certainly reduce the ratio of readings obtained with down-turned and up-turned windows, as a considerable part of the upward illumination must make large angles with the vertical. The absence of an opal glass will also increase the apparent loss of light at the sea surface, a quantity which is not easy to measure accurately except in smooth water.

The range of colour sensitivity of the photometer used is also important. Both red and ultra-violet are extinguished by sea-water very much more rapidly than green and blue; thus a selenium rectifier cell without colour filter (which is more sensitive than the eye to both ends of the spectrum) will, in uniform water, give a much greater extinction co-efficient near the surface than in deeper layers. The copper oxide cells used by Clarke in much of his work, being relatively less sensitive to the ends of the spectrum, do not show this effect to so great a degree. Utterback, who uses the selenium cell (which appears to be more stable than the other), has in most of his work limited the spectral range employed in each measurement by means of colour filters inside his photometer case interchangeable by an electromagnetic device. Atkins and Poole have also used the combination of colour filters with selenium cells in the waters off Plymouth. In the deeper layers—say below 20 m.—the absorption of the spectrum ends has rendered their effect negligible, and a cell without filter will only yield slightly different coefficients from those obtained with green or blue filters.

When allowance is made for any differences in the modes of measurement or of presentation used by different workers there is general agreement between their results. Thus, if, as is customary, we define the coefficient of extinction μ by the equation $-\frac{dV}{dx} = \mu V$, where V is the illumination on a horizontal surface at a depth x m., at a point 10 miles offshore, we might expect to find values for μ rather less than 0·4 for red light and rather more than 0·1 for blue and green. These figures correspond to reductions of illumination to 10 per cent in 5·7 and 23 m., respectively, this depth being equal to $2{\cdot}3/\mu$. As we move inshore μ increases, comparatively slightly for red, much more for green, and even more for blue, so that at an inshore station we might get values like 0·5, 0·3, and 0·4 for red, green, and blue respectively. In oceanic water, on the other hand, the blue and green coefficients fall, Clarke having recorded values about 0·05 for the blue-green light at considerable depths in the Sargasso Sea. The lower layers sometimes are more transparent than those above, so long as they are not too near the bottom, but frequently the water appears to be very homogeneous.

Utterback also made measurements with a selenium cell and a filter which reduced its spectral sensitivity to near that of the eye, and has given values of the illumination in foot-candles and in lux at various depths. By a curious slip, which might be overlooked and thus cause confusion to the reader, the reduction to lux has been made by dividing (instead of multiplying) the foot-candle values by 10·76.

Comparatively small changes in the value of μ will cause very large changes in the illumination at appreciable depths. Thus, a change from 0·08 to 0·12 (which might readily occur at any coastal station a few miles offshore) will reduce the light at 50 m. from 1·8 to 0·25 per cent of the sub-surface illumination. The lower of these values, however, would, on a bright summer day, still be equal to normal daylight about sunset.

The determination of the angular distribution of submarine daylight is not easy, but polar diagrams have been obtained in comparatively smooth and sheltered Swedish waters by Johnson and Liljequist. These workers found that the enhanced extinction of oblique rays caused a reduction of average obliquity with increase of depth. Whitney has also made such measurements in American lakes, and Atlantic waters, even as far off as the edge of the continental shelf, and considers that below 10–20 m. a balance between the effects of scattering and absorption maintains the average obliquity approximately constant. This view has also been put forward by Atkins and Poole, who used a cubical photometer containing six cells set in perpendicular directions. They found that, in the waters off Plymouth, below 10 m. there was no decided change in the ratio of the horizontal to the vertical illumination either with depth or with surface light or conditions, the average obliquity being about 38° corresponding to a mean illumination on a vertical surface about 25 per cent of that on a horizontal one. At a depth of 5 m. in bright sunlight this rose to about 67 per cent for a vertical surface in azimuth facing the sun.

Most workers are agreed that at a level well above the bottom the upward illumination ranges from about 2 per cent of the downward in very clear water to 5 per cent, or more, closer in shore. If we assume that the average obliquity is approximately independent of depth, we readily find from this that only 4–10 per cent of the light cut off in any thin layer is scattered back through angles greater than 90°. As scattering through smaller angles has such an effect in maintaining the average obliquity it must be much greater than this, which seems to indicate that the particles concerned are comparatively large compared with the wave-length of light.

Several workers, including Ruedy, Le Grand, and Whitney, have derived formulæ connecting the visibility of objects under water with extinction and scattering coefficients. One objection to these is the need for assuming some law of angular distribution of scattered light which may be far from the truth. The visibility of an object which is not too small depends on the ratio of its surface brightness, as seen, to that of the surrounding field. This ratio must differ from unity by an amount which is almost independent of the absolute brightness (provided this is not too small), and may, according to Ruedy, be taken as 2 per cent. The chief obstacles to visibility are (*a*) the reduction of the ratio of brightnesses by the addition to both of the daylight scattered by the intervening medium; (*b*) the reduction in absolute difference of brightness by extinction in the intervening medium, including the mixing of light from the object and field by scattering; (*c*) the possible reduction of illumination to such a degree that increased ratios are needed to ensure detection.

The extinction of red light reduces all objects to a green or bluish green hue a few metres under water. At greater depths, when the eye is dark-adapted, colour sensation is lost; visibility is, however, helped by the fact that the maximum sensitivity is then close to the wave-length which is best transmitted by sea-water.

It is evident that the distance at which an object is visible must vary greatly with its direction. A light-toned object, such as the Secchi disk, is probably most visible against the dark background of the water directly below the observer, although here the intervening scattering particles are more strongly illuminated than the object. A dark-toned object should be more visible in a horizontal direction, while the visibility of any object overhead must largely be governed by the degree of small-angle scattering. The presence of direct sunlight would introduce azimuthal asymmetry and further complicate the problem.

It would seem then that, pending further increase in our knowledge of the angular distribution of scattered light and of the resultant distribution of field brightness, it is difficult to estimate with certainty the visibility of a given object from measurements of light penetration alone.

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THE FIGURE OF THE EARTH

A GEOPHYSICAL Discussion was held on August 14 in the rooms of the Royal Astronomical Society, when the subject dealt with was "The Figure of the Earth".

Sir Gerald Lenox-Conyngham opened the discussion with a statement of the values obtained by Airy, Everest, Bessel, Clarke and Hayford for the semi-axis major of the earth and for the ellipticity of figure. In attempts to eliminate so far as possible the effects of local deflexions of the plumb-line, Airy avoided arcs measured in mountainous country, while Everest used only the longest arcs available. The fundamentally important question arises as to whether these local deflexions may be treated as random errors; if so, it is appropriate to use the method of minimum squares in the reduction of the observation. This was the method employed by Bessel, and the fact that Airy did not use it suggests that he did not regard the deflexions as random.

An important development began with Waugh's suggestion to Archdeacon J. H. Pratt, of Calcutta, that he should calculate the gravitational pull of the Himalayas at various stations of the triangulation, with the view of correcting the observed latitudes. The calculated attractions were greatly in excess of those indicated by the observations, and led to Pratt's well-known theory of mountain compensation, and Airy's equally famous hypothesis of the "roots of the mountains". It seemed, then, that at moderate or at great distances the attraction of the mountains was for the most part compensated, and that deflexions observed well away from mountain ranges might be ascribed mainly to local causes, which would have a random effect on observations made at an evenly distributed set of stations.

Burrard's discussion of the accumulated Indian data in 1901 led to an important modification of this view. He found that the local deflexions showed systematic trends in directions parallel to the Himalayas; nor could their amounts be attributed to any system of mountains and their compensation. It was, therefore, incorrect to suppose that mountain attraction did not extend to any great distance, or to treat deflexions as random errors.

In 1909 Hayford published the results of his determination of the earth's axis and figure by a new method. Accepting mountain compensation as normally complete and assuming that below a depth of 113 km. there is hydrostatic equilibrium, he computed the effect of all topographical irregularities at each station of observation, and applied the result of the computation as a correction to the observed latitude, longitude or azimuth, as the case might be. There is, therefore, a difference between the smoothed geoid that Hayford was endeavouring to fit and that which had been dealt with in earlier determinations. Hayford, moreover, uses the data of the United States of America only; if a similar determination covering Australia could be made, the results would be of the highest interest.

Dr. R. Stoneley indicated how closely geodesy, astronomy and geophysics are interconnected. The connexion between the gravitational field of the earth and its geometrical form is noticed as soon as one uses a plumbline or spirit-level. It is natural to use as a reference surface a gravitational equipotential, and the equipotential that coincides with mean sea-level is termed the 'geoid'; since this is not a simple geometrical surface, it is convenient to use for reference a spheroid decided upon by international agreement. In a corresponding way gravity may be compared with a standard gravity formula. The relationship between trigonometrical work and the intensity of gravity is seen in Clairaut's well-known formula; the variation of gravity with latitude determines the ellipticity of the figure of the earth. It is assumed that the ocean is free from shearing stress, but no assumption is made concerning the distribution of density within the earth.

A theorem due to George Green shows that a knowledge of the external gravitational field does not determine uniquely the density distribution within the earth. None the less, some information of a general character is forthcoming from the theory of the earth's attraction; if A, A, C are the principal moments of inertia, M the mass, a the mean radius of the earth, and m the ratio of centrifugal force to gravity at the equator, then the ellipticity (ε) of figure is given by $J=3(C-A)/2Ma^2=\varepsilon-\frac{1}{2}m$. The number J can be found independently from the monthly term in the moon's latitude. The 'dynamical compression' $(C-A)/C$ is known from the period of the precession of the equinoxes, and with the preceding formula leads to the value 0·334 for C/Ma^2, whereas in a homogeneous earth the value would be 0·4. Thus, the earth must on the whole be centrally condensed. Likewise, a knowledge of J and m determines ε with great accuracy.

A further advance can be made if it is assumed that the earth is to a near approximation in hydrostatic equilibrium for forces of long period. The work of Callandreau and of Sir George Darwin then shows that, given ε, m, and the dynamical compression, the value of C can be found; the calculation indeed is so insensitive to the assumed law of density that the known ellipticity cannot be used to test a law of density that gives the correct value of C.

In spite of the restrictions imposed by Green's theorem, one can use observations of gravity over a restricted area to derive some information about the density distribution a little way below the surface. Some of the mathematically possible distributions involve negative masses, and in practice other methods, such as seismic exploration, are available to check gravitational measurements. Within these limitations, much scientifically and commercially useful information may be obtained.

The Astronomer Royal pointed out that the addition of the Callandreau-Darwin theory to the work of Clairaut brings in the assumption that the earth is in hydrostatic equilibrium throughout. Since the actual land surface is not a gravitational equipotential, the validity of this extra assumption requires critical examination. The justification is due to de Sitter, who assumed the earth to be in hydrostatic equilibrium from the centre up to a surface which he named the 'isostatic surface'; the undisturbed surface of the ocean was taken to be part of the geoid, and between these two surfaces the equipotential surfaces would not necessarily be spheroidal, nor would they necessarily be surfaces of equal density. If the hydrostatic condition were satisfied throughout, the upper surface of the (ideal) body representing the earth would be a surface which de Sitter calls the 'ideal surface'. The spheroid which is the best fit to the geoid he calls the 'normal surface'.

If the outer potential of a body which is symmetrical both with regard to an axis of rotation and to an equatorial plane is expanded in a power series in $1/r$ and it is assumed that the surface which is an equipotential surface is nearly a spheroid, the boundary conditions give for a body of the size, mass and angular velocity of the earth the relations

$$J = \varepsilon - 0{\cdot}0017287\,;\quad \beta = 0{\cdot}0086559 - \varepsilon,$$

where β is the coefficient of the term in $\sin^2\phi'$ in the formula for gravity at a point of the earth's surface; as already mentioned, the internal constitution is not involved in these formulæ. If we write H for the dynamical compression $(C-A)/C$, we obtain the equation $J/H = q = f(\varepsilon)$, which is applicable to the ideal surface, but not necessarily to the normal surface.

The definition of the normal surface as the spheroid of best fit to the geoid implies that in the development of both surfaces in a series of spherical harmonics the coefficients of the harmonics of degrees 0, 2, 4 are the same. It follows that for the normal surface J is the same as for the geoid. Writing for the ideal surface $J_1 = q_1H_1$, where q_1 is a function of ε, and for the actual earth $J = qH$, where $q = 3C/2Ma^2$, we have $J = J_1$, and it remains to find the difference between q and q_1. The computation made by de Sitter assumed that the actual earth differs from an ideal hydrostatic earth in having an excess of mass in the continents and a deficiency in the oceans; these mass anomalies are supposed to be isostatically compensated by a 'compensation' which is uniformly distributed throughout the material above the isostatic surface. If the suffix 1 refers to the ideal surface the results become:

$$(C-C_1)/C_1 = -0{\cdot}000{,}000{,}34\,;\quad H-H_1 = -0{\cdot}000{,}000{,}85$$
$$q-q_1 = -0{\cdot}000{,}000{,}03\,;\quad \varepsilon^{-1}-\varepsilon_1^{-1} = 0{\cdot}04,$$

so that the difference in the ellipticities is entirely negligible. If there were no isostatic compensation the difference in the values of ε would have been about two units.

Astronomical theory gives $J = \varepsilon - 0{\cdot}0017287 = q/P(A + B\mu')$, where P is the precessional constant, A and B are known with great accuracy from theory, and μ' depends on the ratio of the masses of the earth and moon. If, then, the assumption is conceded that the earth below the isostatic surface is in hydrostatic equilibrium (and there is evidence that this assumption is not strictly correct), this method gives the value of the compression with a smaller uncertainty than any other method.

Dr. E. C. Bullard discussed how far the values of $1/\varepsilon$ given by various methods agree with de Sitter's result. These values are:

Motion of lunar perigee	296·6 ± 1·2
Motion of lunar node	296·0 ± 1·2
Motion of moon in latitude	297·3 ± 0·9
Gravity observations	296·6 ± 0·5
Lunar parallax	294·7 ± 1·4
Triangulation (Hayford)	297·0 ± 0·5
Precession	297·24 ± 0·044
Nutation	297·61 ± 0·12

Of these determinations, the lunar parallax method depends on measurements at Greenwich and the Cape only, and may be suspected of serious systematic error. The mean of the first three is 296·7 ± 0·6; this astronomical determination, combined with that from gravity observations, gives 296·6 ± 0·4 (A). Accepting de Sitter's justification of the use of the precessional method, which involves the assumption of hydrostatic equilibrium, that method is capable of high precision, and the result differs from the preceding result (A) by 0·6 ± 0·4. This difference may not be significant, but if the difference is real, it implies stress differences of the order of 2×10^7 dynes/cm.^{2}, which are by no means unlikely.

Dr. H. Jeffreys recalled his attempt in 1941 to represent the observations of gravity over the earth's surface in terms of spherical surface harmonics. The problem is not statistically simple, for the existing observations are by no means uniformly distributed over the globe. In that determination, apart from the main ellipticity term, none of the coefficients was certain even as to sign. To carry through a least squares solution with twenty unknowns would involve very heavy computation, and therefore Dr. Jeffreys had now proceeded by a method of successive approximation. As a first step the normal equations were regarded as orthogonal, and only terms large compared with their standard error were retained. Departures from the international gravity formula were represented by

$$g-g_0 = \Sigma(a_{m,n}\,P_n^m \cos m\lambda) + \Sigma(b_{m,n}\,P_n^m \sin m\lambda).$$

The coefficients given by the first approximation, with their standard errors, were $a_{22}=4\cdot8\pm1\cdot3$; $a_{31}=6\cdot2\pm2\cdot3$; $a_{32}=2\cdot0\pm0\cdot6$, none of the others being as great as their standard errors. For a second solution he included a_{00} and also a_{20} (the main ellipticity term) and solved for the five coefficients by least squares. The result was: $a_{22}=4\cdot0\pm1\cdot4$; $a_{32}=1\cdot3\pm0\cdot7$; $a_{31}=4\cdot2\pm2\cdot4$; $a_{00}=2\cdot5\pm1\cdot9$; $a_{20}=-6\cdot1\pm5\cdot0$; and the coefficient b_{33} then had the value of $0\cdot46\pm0\cdot26$. The coefficient a_{22} indicates that the 'ellipticity of the equator' is genuine, but that the uncertainty is greater than that given by Heiskanen.

Compensated inequalities that would account for the harmonics a_{22}, a_{32}, a_{31} and b_{33} would be of amplitudes 5·2, 1·9, 1·9, 2·2 km. respectively. Now Prey computed in 1922 coefficients which give the representation of the earth's figure by spherical harmonics up to degree 16, and from his results it follows that there is practically no relation between mean height and gravity anomaly for inequalities with horizontal ranges of about 30°. Thus, the hypothesis of complete compensation must be abandoned. To explain the distribution of gravity an internal interface seems to be required, the height of which has a negative correlation with that of the outer surface. We have, in fact, strong evidence that isostasy is not exact, and are led to something of the type of Glennie's 'crustal warping'. The value of the reciprocal of the ellipticity of the earth derived from this investigation is 296·17, with a standard error of 0·68.

R. STONELEY.

OBITUARIES

Prof. F. E. Suess

NEWS has been received recently that Prof. Franz Eduard Suess, emeritus professor of geology in the University of Vienna, the son of Eduard Suess, died in Austria about a year ago, aged seventy-four. After many years on the Austrian Geological Survey, he occupied several academic posts before his appointment to the chair in Vienna in 1911. As an enthusiastic pupil of Becke, he was one of the first to make use of the petrology of metamorphism to interpret the history of rocks, a method he applied in grappling with problems of the crystalline massif of Moldanubia and studies of the deeper parts of mountain ranges where intrusions play an important part. Later, he integrated his opinions by enunciating a theory of mountain building through loading caused by the carriage of a moving 'creative mass' over a passive foreland. The ranges as they exist to-day result from the erosion of this structure. Fragments of the load left by chance can be distinguished from the loaded under-ground by the different grade of metamorphism they display, and a passage can be traced from the loaded to the unloaded part of the old foreland. It follows that the occurrence of a mass of crystalline schists in a mountain system is no evidence that they are older than fossiliferous sediments not far away in the unloaded region. Indeed, the sedimentary rocks in the 'creative mass' may be as old as the schists and gneisses formed below them. He regarded the Caledonian, and Variscan ranges of Europe, Asia and America as types of this orogenesis.

Suess was less prolific than his father, but he displayed an enviable erudition in contributions to a host of geological subjects. His lectures in Vienna were popular, partly on account of his masterly use of the German language, and partly because they covered the geological globe in a well-balanced conspectus supported by a background of documented facts. He was particularly attracted to Britain, where his father was born, and visited the Highlands more than once to compare their architecture with that of the Caledonian masses he knew so thoroughly near the Danube. He contributed papers in English on the thorny problems of the structures of the Scottish Highlands, and they provide a welcome variety in a rather mystic literature.

Though somewhat crippled in later years, Suess was surprisingly active, and in pursuit of his science he would walk long days amidst the woods of the Wiener Wald or on his own particular ground not far from the Danube, over the Scottish moors in their less pleasant moods, or brave the winter frosts of the Bushveldt and sleep with only a cloak between him and the stars at an age when such expeditions would dismay most men.

Suess was an LL.D. of the University of Glasgow and had a large circle of friends in Great Britain. He had a discriminating taste in art and music, in both of which he was no mean performer. The former rendered his field notebooks models of their kind as his skilful, truthful pen recorded pictorial evidence unbiased by theoretical distortion and furnished illustrations of field facts in a way that few can hope to do even with the aid of a camera. In the latter, his piano was near his study and upon it he would discourse in a most versatile fashion. Like many an Austrian he loved Mozart and Schubert, Beethoven and Wagner, but besides he was tremendously attracted by the unexpected harmonies of Richard Strauss. He had an unusual knowledge and appreciation of the whimsicalities of Gilbert and Sullivan. He attracted around him a large circle of students and friends who used to meet once a week in one of the parks near the Danube during each summer. To those who knew him he was ever genial and as a man hospitable to a fault.

J. V. HARRISON.

Mr. E. A. Nahum

MR. E. A. Nahum, a research worker in the Cavendish Laboratory, was killed in Cambridge during a recent air raid.

Nahum, who belonged to a Manchester family, was educated at Clifton College and at Pembroke College, Cambridge, to which he went with an Open Exhibition in 1936. He read for the Natural Sciences Tripos and obtained a first class in Part I and in Part II (Physics). He returned to Cambridge with a Goldsmith senior studentship in 1940 and began work on the cyclotron. The Cambridge cyclotron had not long been installed, and as most of the senior nuclear physicists were away, it says much for the young research workers that they not only kept it in running order but also obtained material for four very comprehensive papers on the deuteron bombardment of the heavy elements. In the last two of these, with R. S. Krishnan, which appeared in a very recent number of the *Proceedings of the Royal Society*, the first quantitative measurements were made of the reaction yields, which made possible detailed comparison of experiment with results predicted by the present theory of the interactions of deuterons with heavy nuclei.

Nahum was known to many as a young scientific worker of great promise, but students throughout the world will remember him as a leader of the anti-Fascist movement in the universities. His student life in Cambridge coincided with the struggle of the Spanish people against Fascism and he was the principal leader in building up the student anti-Fascist movement in Great Britain. After David Guest and John Cornford were killed fighting for the Spanish Republic, Nahum took the place of the latter as leader of the Communist Party in the University.

During this period he spent vacations in Paris working as a leading member of the committee of the World Student Association and became known to thousands of foreign students. In his third year, as president of the Cambridge University Socialist Club, he led the struggle among students against non-intervention in Spain, Japanese aggression and the Munich policy of appeasement. In the same year he obtained his first class in Part II Physics.

In subsequent years he continued his work among students both in the National Union of Students, as chairman of the Science Faculty, and as chairman of the University Labour Federation.

In his short life he never failed to put into action his belief that the universities must not isolate themselves from the life of the community and that university people have a vital interest in the progressive movement. At meetings called by the University Labour Federation in different parts of the country, students are pledging themselves to work, train and fight against Fascism as never before as the greatest tribute they can pay to the memory of Ram Nahum. J. D. BERNAL.

NEWS and VIEWS

Centenary of Sir James Dewar

ON September 20 occurs the centenary of Sir James Dewar, one of Great Britain's greatest experimentalists, occupying as he did for forty-six years the chair of chemistry at the Royal Institution and for thirty-six years guiding its destinies both by his position and his discoveries. Dewar added greatly to the lustre of the Institution, and by his many investigations, especially those on the liquefaction of gases and the attainment of high vacua, gained for himself a place among the leading chemists and physicists of his time. Born at Kincardine-on-Forth, he studied under Playfair at Edinburgh and Kekulé at Ghent, and at the age of thirty-three was made Jacksonian professor of experimental philosophy at Cambridge. Two years later he was chosen to succeed Gladstone as Fullerian professor of chemistry at the Royal Institution and after another ten years was made superintendent. The year he went to Albemarle Street had seen the experiments of Cailletet in France and of Pictet in Geneva on the liquefaction of the so-called permanent gases.

Following in the footsteps of his great predecessor, Faraday, Dewar in the early eighties began his own researches on gases which were to lead to many striking results. He first publicly exhibited liquid air, he obtained liquid oxygen and then liquid hydrogen in considerable quantities; in 1892 he invented and freely gave to science and the world the Dewar vacuum flask and in the early part of the present century discovered, as H. E. Armstrong said, "the marvellous power of charcoal to absorb gases at low temperatures " which " will render the period of 1900 to 1907 ever memorable". But Dewar's studies on gases, low temperatures and high vacua are but a part of his researches, which ranged from water to explosives, from atomic weights to spectroscopy, from the properties of soap bubbles to the temperature of the sun. He was elected a fellow of the Royal Society when he came to London in 1877, and lived to receive honours from scientific bodies at home and abroad. In 1904 he was knighted by King Edward. Above all else the welfare of the Royal Institution was his great ambition and anxiety, and after his death which took place on March 27, 1923, a bronze plaque portrait of him was placed on the staircase of the Institution he had served so long and so well.

Sir James Ivory, F.R.S. (1765-1842)

JAMES IVORY, the Scottish mathematician who died at Hampstead a hundred years ago on September 21, had the distinction of being among the first to introduce into Great Britain those methods of mathematical analysis which, from the time of Leibniz and the Bernouillis, had been gradually developed on the Continent. The only mathematical appointment he held was that of professor of mathematics at the Royal Military College then housed at Marlow, in Buckinghamshire. This post he held from his thirty-ninth to his fifty-fourth year. The son of a Dundee watchmaker, he was born in 1765, studied for six years at St. Andrews and Edinburgh and was then, in 1786, appointed a teacher in a school at Dundee. In 1789 he abandoned teaching to become partner in a flax mill, and it was on the dissolution of the partnership in 1804 that he came to Marlow. He gained a wide reputation for his mathematical and astronomical papers in the *Philosophical Transactions of the Royal Society*. He received several medals, including the Copley Medal of the Royal Society, and with several other men of science was knighted in 1831. He was a corresponding member of the Paris Academy of Science.

Soviet Scientific Films

A NUMBER of Soviet scientific films were presented at the Imperial Institute Cinema on September 12 by the Society for Cultural Relations with the U.S.S.R. in conjunction with the Association of Scientific Workers. The films, which covered a wide range of subjects, were of absorbing interest and high technical quality. They included novelties in Soviet scientific and technical practice besides the popularization of well-known facts for children and adult lay audiences. The former featured some excellent photographs of the Black Sea Express, a two-keeled motor sea-glider for passengers, with a speed of fifty miles an hour, Prof. P. Kapitza's miniature turbine for producing cheaply liquid oxygen, and a clever device for protecting workers at the forge from heat with a screen of running water which absorbs the infra-red radiation. An artificial fledgling, made by children, which automatically opens its beak and projects the food inserted by the unwitting mother bird into a bottle of formalin, enabling a complete register to be made of the foods consumed by various birds and their consequent effect on crops, gave an example of how children can contribute to scientific knowledge. A film illustrating the effect of energy expenditure on blood circulation and showing the function of the spleen, and a clear exposition of Lena Stern's method of treating shock extended the programme to the field of medicine.

The final film, "Experiments on the Revival of Organisms", was undoubtedly the most impressive. After a brief and exceptionally clear pictorial explanation of the function of the heart and lungs, the film leads up from the artificial setting in motion of an individual organ, the heart, to the revival of a dog's severed head and finally to the revival of the animal itself, from which the blood has been completely drained off and the heart-beats and respiration of which had ceased for ten minutes. The blood is re-circulated by means of an artificial circulatory system, the 'autojector', the deceased animal heaves its first sigh, heart-beats and respiration begin to register, and, after a short time, the autojector is disconnected and life proceeds. Within a few days the dog is its normal self again and, as the film shows, "lives happily ever after". The producers are to be congratulated on the skill and beauty of this film, which, while maintaining full scientific clarity throughout, nowhere offends the æsthetic senses, opens up an unlimited perspective of scientific advance and cannot fail to instil into the most unimaginative minds a profound respect for scientific effort and achievement. The commentary to the films was prepared by Prof. J. B. S. Haldane.

Mr. Arthur Elton, in his opening remarks, dwelt on the systematic way in which the popularization of science is treated in the U.S.S.R. and stressed the necessity of a scientific approach on the part of the whole population in the interests of the maximum war effort. This view was expanded in an introductory lecture by Dr. M. Ruhemann, who pointed out that, in the U.S.S.R., the diffusion of scientific knowledge and a scientific approach to life has always been considered a matter of urgent necessity, whereas we have tended rather to regard it as a luxury. Reviewing Soviet methods of popularizing science, in books, newspapers, in children's clubs and on the collective farms, he directed attention to the lack of scientific and technical knowledge among young people in Great Britain, due to a large extent to an antiquated school curriculum, and to the tragic consequences which this is bound to have on the efficiency of our Forces in a highly mechanized war. Mr. D. N. Pritt moved a vote of thanks to the speakers and the promoters of the meeting, which was so well supported that large numbers had to be turned away. A repetition of the exhibition is being considered.

Imperial Institute

THE extensive facilities available at the Imperial Institute, London, S.W.7, for the rapid supply of technical information relating to the trade, occurrence and utilization throughout the world of all kinds of raw materials, and the scope of the intelligence service are not so well known as they should be. The Institute's staff includes tropical agriculturists, chemists, chemical technologists, economic botanists, economic geologists, mining engineers, mineralogists and statisticians, and, when desirable, the Institute seeks the advice of members of its fifteen consultative committees. Further help is also afforded by numerous trade contacts. The Institute also has an extensive reference library and a technical index covering most of the relevant trade and scientific publications issued during the past thirty years. The Institute can deal with inquiries relating to sources of supply of, and other information relating to, raw materials and semi-manufactured products whether of animal, plant or mineral origin in all countries, cultivation of crops and the soil and conditions under which they have to be grown, methods employed in mining, smelting and dressing minerals for the market, and so on. Analysis and testing of samples of raw materials is undertaken in the laboratories of the Institute. Inquiries should be made in the first instance to the Intelligence Section of the Plant and Animal Products Department or of the Mineral Resources Department, according to the nature of the subject concerned. No charge will be made for services to Departments of the United Kingdom Government or other Governments of the Empire contributing to the general funds of the Institute unless a particular inquiry involves a volume of work so great that it cannot be undertaken by the existing staff.

The Rockefeller Foundation

DURING 1941 the Rockefeller Foundation appropriated more than nine million dollars for public health, medical sciences, natural sciences, social sciences, humanities and a programme in China. The work in public health received the largest appropriation—2,450,000 dollars. Medical sciences came next with 2,120,000 dollars. The Foundation distributed 1,938,300 doses of yellow fever vaccine to the United States Government and 1,972,386 doses to Africa. Including the total sent to India, Brazil and Singapore, the Foundation gave a grand total of 4,260,680 doses of its own manufactured yellow fever vaccine. The Paris office of the Foundation closed in July 1941, and there are now no Foundation representatives on the Continent of Europe, though an office is being maintained in London. The Far Eastern office was removed from Shanghai to Manila late in 1940. Important studies are being carried out in Malta, in Trinidad and on the Burma Road.

Detection of Cracks in Engineering Materials

A VALUABLE development in the use of fluorescent light is its application to the detection of flaws or cracks in engineering materials, and a demonstration showing its effectiveness was recently given by Colloidal Research Laboratories, 66–70 Petty France, London, S.W.1. Their 'Glo-Crack' system, as it is named, marks a great advance on existing methods and makes the detection of the least visible form of crack as nearly as possible a certainty. The articles to be examined are first immersed for a short period in a hot bath of fluorescent material. They are then transferred to a second bath containing a solution which removes all the fluorescent material except that which is entrapped in any flaws or cracks. This part of the process is very much the same as the familiar one of degreasing and, as a secondary advantage attached to the new process, it may be mentioned that the hot bath is actually an efficient degreasing agent.

After this preparation, each article is examined under ultra-violet light and every small flaw or crack glows with the characteristic colour while the remainder of the specimen remains dark. In this way a crack, no matter how fine, can scarcely escape detection, and this is attained without severe eye-strain or mental fatigue on the operator. Other advantages which the demonstration exhibited are its applicability, without staining or the necessity for after-treatment, to all metals and to many other materials, its simplicity and cheapness of operation, and the quickness with which the process can be carried out, even on mass-produced articles.

While the normal technique is that of dipping in the fluorescent bath, this can be varied to suit special cases. An exhibit of special interest was a flaw in the interior of the base of an aeroplane propeller blade. The hole had been sprayed with the fluorescent solution and after being washed out, the insertion of a black lamp showed the flaw glowing clearly with fluorescent light. This obviously valuable scientific process was shown in its adaptation to the practical requirements of engineering, but its great possibilities suggest a much wider field of application both in scientific investigation and industrial development.

Magnetic Crack Detectors

AN article in the *Electrical Review* of August 28 describes a magnetic detector used to facilitate crack detection in motor and aero-engine parts. While radiographic methods of crack and blow-hole detection possess undoubted advantages when the flaw lies below the surface, for superficial cracks and defects as much as $\frac{1}{4}$ in. below the surface, the magnetic crack detector offers advantages in the speed and economy of its application. The general principles of the method have been described in the *Electrical Review* of April 4, 1940. They consist briefly of subjecting the part under test to a magnetic field and applying a magnetic powder, or a liquid medium containing such powder, to the suspected surface, so that any polarity due to a crack is rendered visible to the eye by collection of the magnetic particles over it.

The crack detector described, known as the 'Magnaflux' (Equipment and Engineering Co., Ltd.), possesses the special feature of sliding laminated pole tips between which the object is mounted for inspection. A few seconds only are needed to adapt them to objects of almost any shape by merely sliding the laminations up to the contour of the specimen. A further feature is that means are provided for controlling the magnetizing current, which is important on account of the need for avoiding supersaturation, or insufficient saturation. There is an optimum degree of magnetization giving the most readily seen and crisply defined crack outlines. Demagnetization of the tested parts is effected by laying the objects on a horizontal platen magnet, or subjecting them to an A.C. field: demagnetization is practically instantaneous.

Electricity in a Beet-Sugar Factory

B. SMITH has described (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 10; Aug., 1942) the application of electricity in the treatment of sugar beet through all the stages to the ultimate production of pure sugar. Although many factories in Great Britain have applied electricity in the best manner possible within their limited expenditure, yet both in the factory and in the laboratory there still remains much room for further improvement. For example, individual drives could be installed in many places where at present one large unit and line shafting now exist, and provided they are suitably interlocked—especially where elevators and conveyors work in conjunction—would prove a great advantage. Again, the sugar house should be equipped with the best type of sugar-spinning centrifugals. Much has been done by the manufacturers in conjunction with the users to improve this class of machinery.

The Electrified Cane-Sugar Factory

IN a paper on this subject (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 10; Aug., 1942) L. B. Whitaker deals with some of the considerations relating to total electrification of such factories, with special reference to the factory at Gray's Inn, Jamaica. Reasons are cited for the slow adoption of the totally electrified sugar factory in the British Empire as compared with other parts of the world. A brief general description of the processes involved is then given, advantages and disadvantages being discussed and some comparison drawn with steam-driven plants. The necessity of having a sugar factory specially designed for all-electric drive is then stressed, and details are given of the general layout of such a plant to obtain the maximum benefits of total electrification. The most suitable type of apparatus to employ is discussed, including notes on power-factor correction and maintenance routine. The paper concludes with examples of typical power consumption and cost of generating current.

Rural Electrification and Research

AN article by A. G. H. Dent (*Electrician*, August 21) surveys the necessary and probable trend of rural electrification and research in Great Britain during the post-war construction period. The author opens with a reference to the national education in food values and uses. The national neglect of agriculture is ended, and any positive reconstruction policy must incorporate broad measures of industrial decentralization of agricultural development and of food—or health-education. The article proceeds to define the position and responsibility of the public utility company in such a scheme, stressing that the words 'public utility' imply usefulness to the public as a national service forming an essential part of the social structure.

The recent introduction into farming of a minimum wage for agricultural labourers of £3 per week is cited as an incentive for electrical methods of carrying out farming operations on a continually increasing scale; with such a demand will come the need for electrical apparatus and machinery for doing the work. During the last few years, root cooking by electrical methods has been successfully employed, while the electric wash boiler has found application in the boiling of potatoes. There appears to be a demand for a cheap, low-loaded apparatus, of 1–3 kw., designed especially for root cooking. Bottle washing, herb drying, and the provision of hot water for feeds and mashes are also quoted as more recent uses of electricity in farming.

Mention is made of a G. E. C. (U.S.A.) experiment in which fruit trees and seeds are bombarded by X-rays in an attempt to improve the size, quality and flavour of the fruit. It is thus evident that a technique may be developed for the more intensive electrification of agricultural processes and that changes may be brought about gradually in farming methods.

Epidemics in English Villages

In his Milroy Lectures for 1942 before the Royal College of Physicians (*Univ. Leeds Med. Magazine*, 64, 12; 1942) Dr. W. N. Pickles, the energetic medical officer of health for Aysgarth in Yorkshire, chose for his subject "Epidemic Disease in English Village Life in Peace and War". He makes a strong appeal to country doctors to follow his example in keeping diligent records, preferably in chart form, of various epidemics in their districts such as influenza, scarlet fever, measles, German measles, mumps, acute rheumatism and cholera, summer diarrhœa, epidemic jaundice and epidemic myalgia, the last being a disease which Dr. Pickles was one of the first in Great Britain to describe. Contrary to what he had expected, Dr. Pickles has so far not found that war conditions have caused an increase of epidemic disease, although village life has changed to some extent owing to the immigration of town children. Since the outbreak of the War there has been no scarlet fever or infantile paralysis in the Aysgarth district and only a few cases of measles and cerebrospinal fever, while the only epidemic due to an evacuee was one of jaundice, of which there were fourteen cases. The chief sources of annoyance were impetigo, vermin and scabies, but these were soon brought under control.

Public Health Research

According to an annotation in the *Journal of the American Medical Association* of July 25. the Health Research Institute of the City of New York will receive a million dollars a year for ten years for researches on public health. The City and the Institute, which is a non-profit scientific institution, have entered into a contract which came into effect on July 1 and is automatically renewable for similar periods. The money is to be used to carry on fundamental medical research under the direction of a research council composed of authorities in medicine, biology, physiology, nutrition, public health and related subjects. Under the contract the services to be rendered by the Institute will include the following: (1) investigations into the control of diseases such as influenza, poliomyelitis, arthritis, degenerative diseases and general physiological problems; (2) engagement in laboratory experimentation in order to develop better and more economical biological products and improved technical procedures for use in controlling diseases and epidemics; (3) aid to the director of the Bureau of Laboratories of the Department of Health in matters involving public health research.

Electronic Relay Control

One of the more useful by-products of the rapid development of radio technique is the use of thermionic valves as relays of negligible input power, freedom from contact troubles and practically instantaneous operation. These features are utilized to the full in the series of devices and instruments now marketed by Messrs. St'r Electronic Controls, 76 Cavendish Road, London, S.W.12, as the result of considerable experience. One of the devices comprises an electronic relay operating on the usual alternating current supply of 230 volts 50 cycles per second, and giving an output of either 200 or 1,000 watts, the latter being capable of starting a ½ h.p. motor on 230 volts A.C. supply. This operation is obtained with no time delay, and with an effective current through the regulating contacts of about two microamperes. The same instrument may also be used for high speed machine timing operations, or the regulation of temperature, pressure, humidity or hydraulic flow. As an example, a laboratory type of constant temperature bath is available, in which the accuracy of regulation is better than ± 0·01° C. Another type is a liquid level regulator, with no float or other moving parts within the container; this is particularly suitable for use with electrolytes, and the electrodes may be a fraction of an inch apart or several feet from each other. An electronic 'stop-watch' records time intervals up to 2,000 seconds in intervals of a fifth of a second. It seems likely that these and other similar devices will find widespread application to laboratory and industrial processes.

Ice on Conductors

From time to time overhead lines fail by mechanical overstresses alone, due to excessive ice loading. These deposits have been widespread, and in view of the severity of recent winters, J. McCombe (*Elec. Rev.*, Aug. 21) suggests that an amendment of the Electricity Commissioners' Overhead Line Regulations El. C. 53 (revised) is necessary. The suggestion is supported with the following observations and criticisms. In the first place the selection of a different basic loading for high- and low-voltage lines is very much open to criticism since wind and ice loading are functions of exposure and altitude and definitely not of line voltage or conductor size. Deposits on overhead lines in exposed places are more or less constant irrespective of voltage. If a better standard of construction is desired, then the more logical method would be to adopt a higher factor of safety of erection. Low-voltage lines with the same ice coating will always have a greater security owing to the shorter span-length employed.

In the Regulations referred to, assumptions have been made to simplify the problem of ice loading. The ice is taken as forming a true annulus around the conductor. The author's observations are that ice is never deposited evenly or uniformly, either in wind or calm. Its nature depends to a great extent on the prevailing wind and atmosphere. In wind, ice tends to form thickest in the leeward side of the conductor. Windage helps to build up ice deposits, in as much that each particle of sleet imparts kinetic energy due to the wind and is responsible for the heavier deposits being driven to leeward. It probably also accounts for the different ice densities encountered on overhead lines. The worst deposits, however, are due to fog, not to wind and sleet. The heaviest deposits result from fog in the presence of a light wind, when icing is worst on the windward side of the conductor. It is thought that the fog precipitates ice as soon as it finds a metal anchorage. Such ice usually has a heavy, solid core, but becomes fuzzy and less dense on the surface. The article concludes with the suggestion that grading or zoning of the country, according to climatic conditions, would be advantageous, and by way of illustration describes the way this is done in the U.S.A.

Recent Earthquakes

According to the Swiss Seismological Bulletin for June 1942 just received from Zurich, twenty-one earthquakes were registered by the seismographs at

Chur, Basel, Neuchâtel and Zurich during the month. The following have not been mentioned previously in the columns of NATURE: An earthquake on June 1, registered at Chur at 09h. 04m. 11.7s. U.T., which came apparently from an epicentre near the Presse Griechenland. The earthquake of June 20 which registered at Chur at 14h. 42m. 01·8s. U.T. came probably from Trentino, Valle Judicaria, in Italy. The earthquake of June 25, which registered at Chur at 22h. 13m. 13·9s. U.T., came apparently from an epicentre at Mürtschenstock, Kt. Glarus, Switzerland, and was felt with intensity IV–V.

The earthquake of August 24 in Peru (NATURE, September 5) was registered at Kew at 23h. 03m. 36s. U.T. and attained a maximum ground amplitude at Kew of 1,520 μ. The earthquake of August 27 in the Balkans (NATURE, September 5) was also registered at Kew at 06h. 18m. 16s. U.T. and attained a maximum ground amplitude at Kew of 210 μ.

THE United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association has determined the epicentres of several recent earthquakes near South America. These determinations have been based on instrumental reports from fifteen observatories. Altogether there are seven shocks, six being near latitude 0·8° N., longitude 80·5° W., which is just off the coast of northern Ecuador in South America. The dates of the shocks were all in July—4 (2), 5, 7, 8 and 12. The seventh earthquake was on July 8, and its epicentre was near latitude 25·5° S., longitude 79·5° W., which is in the bed of the Pacific Ocean off the coast of Chile, and north-east of the islands of San Felix and San Ambrosio.

Data for Radio Engineers

A SMALL publication (Reference Data for Radio Engineers. Pp. 60. Standard Telephones and Cables, Ltd., 63 Aldwych, W.C.2. 2*s.*) should find a ready appeal to all radio engineers, whether they are engaged in replacing a small fixed resistor in a wireless receiver or a piece of laboratory apparatus, or working on the design of a world-wide radio telephone service. The data included in this booklet have been selected as a result of the experience of engineers engaged in the development of radio communication systems during the past twenty years. A very wide field is covered including electrical and mechanical constants, properties of materials, circuit theorems, impedance operators, abacs and other data of everyday utility to those conducting design and development work. A noteworthy inclusion is that of wave propagation curves summarizing the best technical knowledge available at an international conference held in 1938. The above material is supplemented by a generous amount of mathematical formulæ, and the usual tabulated quantities up to and including tables of Bessel functions, the need for which has grown so rapidly of recent years in connexion with phase- and frequency-modulation systems. Since the effectiveness of any communication link, land-line or radio is nowadays expressed in terms of the ratio of the wanted signal to the noise-level, it is only natural to find a few pages devoted to noise determination and measurement, and charts showing the relationship between the European and American units in the standardization of noise measurement. The reference book is a commendable effort in a comparatively new field.

Announcements

SIR ROBERT RENWICK has been appointed to the newly created post of Controller of Communications Equipment in the Ministry of Aircraft Production, and will become a member of the Aircraft Supply Council. He will be assisted by Sir Robert Watson Watt, as vice-controller. Sir Robert Renwick has also been appointed controller of communications in the Air Ministry, where Sir Robert Watson Watt will continue to hold the appointment of scientific adviser on telecommunications. These arrangements will ensure still closer co-ordination between the two departments in this important field.

THE following appointments in the Colonial Service have recently been made: P. H. Richards, agricultural officer, Nigeria; B. J. Silk, agricultural officer, Gold Coast; M. P. Ford, veterinary officer, Kenya; A. E. G. Markham, veterinary officer, Kenya; C. O. Oates (agricultural officer), senior agricultural officer, Kenya; K. Wallis (government analyst, British Guiana), government chemist, Uganda.

ARISING out of a recommendation made to the Council of the British Association at the conclusion of the Conference on European Agriculture, a committee has been appointed, under the chairmanship of Sir John Russell, to collaborate with the Allied Technical Advisory Committee on scientific problems connected with the post-war reconstruction of agriculture in the devastated and oppressed areas of Europe. The Council of the Association has also appointed a committee, under the chairmanship of Dr. Dudley Stamp, with the view of strengthening the applications of science (for example, geology, geography, ecological botany and zoology, soil science, agricultural economics, and forestry) to rural planning in particular.

THE first lecture in the autumn programme of the thirtieth annual series of Chadwick Public Lectures will be given at the Royal Society of Tropical Medicine, 26 Portland Place, London, W.1, on October 6, at 2.30, when Sir Leonard Hill will lecture on "The Inter-Relation of Clothing and Shortage of Fuel in Matters of Health". Sir William J. Collins, chairman of the Chadwick Trustees, will preside, and shortly before the lecture (at 2.15 p.m.) will present the Chadwick Medal and Prize to Mr. Wilfred Glyndon May of University College, London. Admission to all the lectures is free and tickets are not required.

THE Medical Research Council invites applications from medically qualified women for a studentship for training in methods of experimental psychology; preference will be given to candidates who have had some special training in physiology or neurology, or who have already had some experience in the use of research methods. The studentship will be tenable for six months, during which the holder will receive training under the direction of Prof. F. C. Bartlett at Cambridge. Payment will be at the rate of £350 per annum and the student will be expected to give her whole time to the work. Further information can be obtained from the Secretary, Medical Research Council, c/o London School of Hygiene, Keppel Street, London, W.C.1, to whom application should be made by October 5.

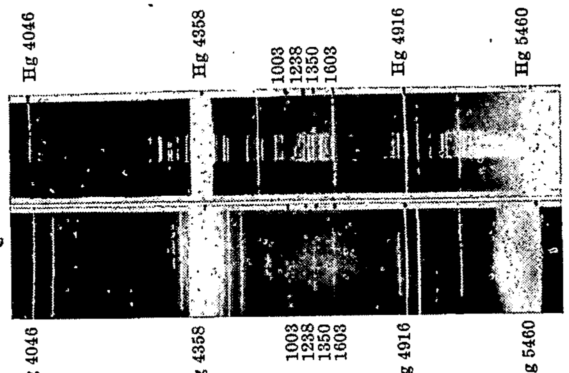
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Raman Spectrum of 1,3,5-Triphenyl Benzene

In two previous communications[1] one of us has reported investigations on the structure and Raman spectra of some of the polynuclear aromatic compounds, and we have also submitted elsewhere[2] details of the results on the *ortho-*, *meta-* and *para*-diphenyl benzene. In continuation of those investigations we have studied the Raman spectrum of symmetrical triphenyl benzene, in solution in carbon disulphide and carbon tetrachloride and also in other suitable solvents. The melting point of this substance is fairly high and it presents the difficulty that as its temperature is raised to its melting point it tends to become unstable and decompose.

Two of the spectrograms of the substance taken in solution using a Füess glass spectrograph and some suitable filters are reproduced here. The substance is highly fluorescent under the total radiation of the mercury arc, but it will be seen that owing to the large diminution in the intensity of the 4046 A. group of mercury lines, the fluorescence is not appreciable and the background is quite clear. The frequencies observed and found common in both carbon disulphide and carbon tetrachloride solutions are at 3046(1), 2036(4) ?, 1603(8), 1496(1), 1350(6 br.), 1238(4), 1045($\frac{1}{2}$), 1003(10), 603(1), 406(1), 234(1), 170(5), 146(6) and 87(4 br.) cm.$^{-1}$ respectively (intensities are given in brackets). A few more lines have also been observed in acetic ether and chloroform solutions at frequencies, 2987(4), 1458(5) and 384(5) cm.$^{-1}$. As the excitation of these lines was due to λ 4358 alone, it is expected that the assignment is free from error.



a, triphenyl benzene in CS_2 solution ; *b*, triphenyl benzene in CCl_4 solution.

The most significant points of resemblance were found with the spectra of *m*-diphenyl benzene, which consists of three benzene rings, two of these being substituted in the third in the meta position. Symmetrical triphenyl benzene consists of four benzene rings, three of which are substituted in the fourth in positions 1, 3 and 5. Loss of any one of these three benzene rings converts the substance into *m*-diphenyl benzene. The close agreement between the majority of triphenyl benzene frequencies and those of *m*-diphenyl benzene will be found in the following *m*-diphenyl benzene frequencies obtained by one of us[3] and S. Abdul Aziz. These frequencies are at 1607(4), 1350(0), 1241(4 br.), 1039(1), 1000(10), 611(3), 406(3), 238(3 diff.), 151 (2 diff. and br.) and 80 (4 diff. and br.) cm.$^{-1}$.

The strongest frequency of triphenyl benzene, observed at 1003 cm.$^{-1}$, is found equally strong in *m*-diphenyl benzene and is also present in all the other compounds of this series. But the marked dissimilarity is that the very strong line at 1309 cm.$^{-1}$ observed in *m*-diphenyl benzene and almost equally strongly in all the other compounds of this series is found to be completely missing in this compound. The other very marked difference is that the stronger frequency of the doublet at 1597 cm.$^{-1}$, also found in all the compounds of this series, is not observed in triphenyl benzene. A few of the other lines observed here are also present in benzene and are therefore due to the vibration of the benzene ring. The line at 88 cm.$^{-1}$ is due to the molecule itself, although the frequency is very low as the substance was studied in dilute solution.

These results are expected to give a clue to the symmetry and nature of the disposition of the substituted phenyl groups of this compound.

Further work is in progress, and a discussion of the bearing of these results on the nature and symmetry of the benzene rings of this compound will be published elsewhere.

S. K. Mukerji.
Laksman Singh.

Physics Department,
Agra College,
Agra.
June 26.

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[1] Mukerji, Nature, **142**, 477 (1938); also Mukerji and Laksman Singh, Nature, **144**, 382 (1939).

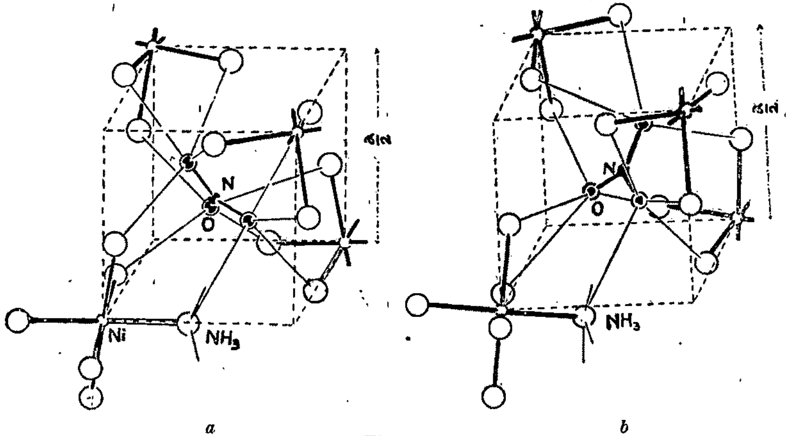
[2] Mukerji and Aziz, *Ind. J. Phys.*, **13**, Pt. 3 (June, 1909).

[3] Mukerji and Aziz, *Phil. Mag.*, (7), 31, 231 (March, 1941).

Formation of a Double Crystal Aggregate and the Structure of the Intermediate Temperature Modification of $Ni(NO_3)_2.6NH_3$

About five years ago I made an X-ray study in Manchester, under Sir Lawrence Bragg's kind supervision, of the structure of $Ni(NO_3)_2.6NH_3$ at different temperatures. Three modifications were observed and the structure of the room temperature modification was determined[1]. Attempts were made without success to find the structure of the intermediate temperature modification on the assumption that the structure had the symmetry (F43*m*, F43, or F*m*3*m*) shown by its X-ray photographs. It was not until three years had elapsed that an idea of the partition of a single crystal into a double crystal aggregate came to my mind, and hereupon a structure was obtained which can explain very naturally and satisfactorily all the X-ray intensity data of more than 300 reflexions. In view of the interest in the mechanism of the conversion from the room temperature to the intermediate temperature structure and in the formation of the double crystal aggregate, it is thought probably opportune to give a brief account of the work here.

The intermediate temperature modification of $Ni(NO_3)_2.6NH_3$ is obtained by cooling the crystal grown at room temperature by a stream of liquid air falling on it at a suitable speed. The modification belongs to the cubic system, like the room temperature modification; its structure also consists of flat triangular NO_3 and octahedral $Ni(NH_3)_6$ groups interlocking one another into a CaF_2 grouping. Unlike the room temperature modification, however, the NO_3 groups in the present structure no longer execute any abnormal oscillation, but assume either one of two alternative configurations roughly corresponding to the two extremities of an oscillatory NO_3 in the room temperature structure[1]. Now suppose that at the very beginning of the conversion of the modifications from the room temperature to the present, a particular NO_3 group in the crystal, owing to the loss by cooling of its oscillation energy, assumes one of the two alternative configurations. The change of the state of this NO_3 group will immediately bring about a modification of the configurations of its neighbouring NH_3 groups; the modification so caused then in turn makes the other neighbouring NO_3 groups assume the more probable of the two alternative configurations. These NO_3 groups then cause their own neighbours to change their positions, and the propagation of this process finally results in a structure which has the space group *Pa*3. If the NO_3 group which starts the conversion assumes the other one of the two alternative configurations, the resulting structure is the same as the one just mentioned, except that the orientation of the second structure, when looked at along a cube axis, differs by 90° from the first one. In Fig. 1 (*a*) and (*b*) are shown the alternative configurations of a NO_3 group the original configuration of which in the room temperature structure is shown in Fig. 1 in reference (1).



a *b*

Fig 1.

Now let us consider the conversion process taking place in the whole crystal. We first expect that the conversion must be started simultaneously and independently by a considerable number of NO_3 groups in the crystal, like the solidification of a melt being started by the growth of grains from numerous nuclei in the melt. However, the nuclear NO_3 groups here can assume only two possible configurations instead of any random orientation, the consequence of which is that the resulting crystallites, after the conversion is completed, must have their crystal axes confined to two mutually perpendicular directions, that is, the directions of the axes of the original single crystal. Furthermore, the external shape of the crystal is not changed. On these accounts, the spots on the oscillation photographs of this crystal appear as if they were reflected from a single crystal, except that each spot is a superposition of two reflexions *hkl* and *khl* on the photographs taken with the crystal oscillating about the [001] axis. Thus the symmetry shown on the photographs is not the actual symmetry of the structure. Since the crystal is neither a single crystal nor an ordinary polycrystalline mass, I tentatively call it a 'double crystal aggregate'. A schematic representation of a section of the aggregate perpendicular to the [001] axis is shown in Fig. 2.

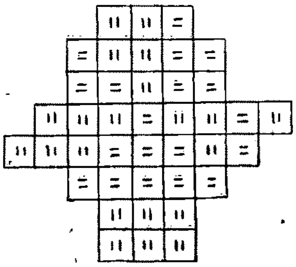


Fig. 2.

The discovery of the aggregate leads us to the following considerations:

(1) The determination of the space group of a structure must be made with due consideration of the possibility of the formation of an aggregate of double or even similarly defined triple crystal when the X-ray oscillation photographs used for the space group determination are taken with the crystal at a temperature different from the one at which the crystal is grown.

(2) It might be expected that the crystalline grains in some polycrystalline metals are really not single crystals but composed of aggregates of the preceding kind, if the metals cooled down at a moderate rate from a high temperature have their structures at the final temperature bearing a favourable geometrical relationship with their structures at the initial temperature. Since numerous new intergranular boundaries must exist within each aggregate we naturally raise the question as to the nature of these new boundaries. If they are of the same nature as the ordinary intergranular boundaries, we should expect a metal to be hardened by the formation of such aggregates. Since the formation is brought about by a mechanism (not necessarily involving any abnormal oscillations of some atom groups in the initial structure, of course) totally unknown before, and the resulting product of the formation is in a quite stable state, the study of this formation in metals would introduce a new type of hardening process in physical metallurgy. On the other hand, if the new boundaries differ in their physical properties from the ordinary ones, a study of this difference might add some knowledge to the understanding of the nature of the latter. Again, we might have the question of whether these new boundaries have anything in common with the boundaries between blocks of the mosaic structure of a crystal. Finally, I should remark that the new boundaries cannot be detected either by the etching and microscope method or by the X-ray method of the powder photograph.

A detailed account of this work will appear elsewhere.

I wish to express my sincere thanks to Sir Lawrence Bragg for his suggestion of this problem and for the keen interest he took in the work; also to Mr. P. Y. Hwang, who made the final adjustment of the parameters in the structure.

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[1] Yü, NATURE, 141, 158 (1938).

Mechanism of Metallic Friction

DR. BOWDEN and his collaborators[1] in their investigations on the mechanism of metallic friction need have little doubt that, under many of the conditions of load and speed used in practice, the local temperatures reach a high value. Very high local temperatures are attained in very short intervals of time, as those who have observed 'seizure' taking place between the cylinder or liner and piston in an internal combustion engine can testify. The opportunity of witnessing this occurrence is rare in modern engine design with closed crank cases, but in the days of the horizontal gas engine, with the open-ended cylinder and trunk type piston, high temperature, often a white heat, was frequently observed when 'seizure' took place.

Probably at that time before the days of ground finishes, 'seizures' on the test bed were a more frequent occurrence. The dimensional accuracy of the 'fit' allowances, in addition to the character of the wearing surfaces, which were finish turned and bored, contributed to this state of affairs. Engineers certainly relied very much more on 'running in' to establish satisfactory working surfaces. I recorded some observations on these matters in a paper before the Manchester Association of Engineers in 1916.

Examination of 'seized' surfaces of cylinders, pistons and rings showed 'flowed' failures, and I well remember our chief engineer in those days being profoundly convinced that such layers had been molten and consisted of metal melted during the 'seizure'.

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[1] See NATURE, 150, 197 (1942).

Shape of Subjective Space

IN a discussion of blind spot phenomena, Bartley[1] raises the question as to whether points subtending equal visual angles are subjectively equally separated, and suggests that the form of subjective space is related to the density of the rods and cones in the retina.

A theory that each sense-cell (or rather each fibre of the optic nerve, where more than one cell converge on to one fibre) contributes equally to the formation of subjective space would find much evidence to substantiate it; for example, the apparent uniformity of the brightness of the visual field, in spite of the variations in population of sense-cells in the retina; variations in subjective velocity of bodies moving at constant velocity in the field of vision, etc.

The gross distortion of subjective space in the region of the blind spot, because of the lack of sense-cells in the optic disk, is well demonstrated by the subjective filling in of various incomplete figures made to fall across the blind spot, as described by Helmholtz and others.

A binocular phenomenon which I have recently observed has some bearing on this and related questions. If a stereoscopic photograph is examined, first so that the relief stands out, and then by inverting so that although the two halves fuse there is no stereoscopic effect, the objects in the picture appear to increase in size. If one eye is then closed, the original sizes return. Reversing the procedure gives opposite effects.

An arrangement of mirrors was set up so that the right eye would see from the point of view of the left eye, and the left eye that of the right, so that binocular fusion without relief would be obtained. Observers were asked to judge the lengths of slips of paper held successively in the field of view, first with one eye only and then with both eyes. Estimates of size in the two cases were in the ratio of 3 to 4; that is, there is an apparent magnification in area of almost two.

It would seem that binocular fusion without stereoscopic effect is equivalent to doubling the numbers of active sense-cells and consequently the subjective size, while where stereoscopic vision is concerned some sort of unification of corresponding sense-cells in the two eyes takes place so that they behave as one—a possible explanation also of Fechner's paradox.

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July 25.

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[1] Bartley, S. H., "Vision: A Study of its Basis" (London: Macmillan and Co., Ltd.), p. 114.

Role of Adenine Nucleotides and Growth Factors in Increased Proliferation following Damage to Cells

STIMULATION to tissue repair in wound healing has been attributed variously to polypeptides and amino-acids[1], sulphhydryl compounds[2], nucleoproteins[3], fatty acids[4], or certain nucleic acid derivatives[5], and it has been proposed that the stimulating substances are secretions of leucocytes ("trephones"[1]) or damaged-cell disintegration products ("wound hormones"[13]). Since cell secretions or damaged-cell products influence normal cells through the intercellular *milieu*, a direct and quantitative approach to this problem is afforded by the comparison of intercellular fluids from damaged cells (I) and from normal cells (II), with regard to their chemical composition and effects on cell metabolism. Such comparisons have shown that (I) greatly exceeds (II) in stimulating cellular proliferation[6,7] and respiration[8,9] and in increasing capillary permeability[10], and that when (I), but not (II), from animal tissue sources is injected repeatedly into animals, overgrowths result[7].

In the following experiments, cell-free, injured-cell suspension fluids (I) and normal-cell suspension fluids (II) from yeast suspensions (*S. cerevisiæ*, F. B. Strain, 100 gm. per l. in distilled water) were compared. Injury was by 8 hr. sublethal ultra-violet irradiation[11], which produced negligible cytolysis, but caused marked increase in the permeability of the damaged cells, accompanied by loss of turgor and shrinkage in cell volume (*ca.* 30 per cent). Both (I) and (II) were substantially free from protein, as in previous experiments[6] (negative biuret and phosphotungstic acid tests and negligible 2700–2800 A. absorption characteristic of proteins, tyrosine or tryptophane). The proliferation-stimulating potencies of (I) and (II) were respectively 98·0 and 3·3 growth units per ml.[12], the solid contents 3·17 and 0·245 mgm. per ml. and the ultra-violet absorption $([1/x]\log_{10}[I_0/I_x])$ at 2600 A., characteristic of nucleotides, 7·0 and 1·4. Thus, the grossly intact damaged cells released, as a result of increased permeability, appreciable amounts of growth-stimulating substances and nucleotides.

EFFECT OF ADENENINE NUCLEOTIDES, KNOWN GROWTH FACTORS, AMINO-ACIDS AND DAMAGED-CELL PRODUCTS ON THE GROWTH OF YEAST IN READER'S MEDIUM.

Addition to medium (concentrations in the cultures)	24 hr. yeast crop, mgm. (wet weight) per ml. (initial seeding, 0·064 mgm. per ml.)		
	R	*R+A*	*R+A+B*
Supplements only (controls) ..	0·152	3·08	4·43
(I) Intercellular fluids from injured cells, 0·05 ml. per ml.	3·70	4·03	5·04
(II) Intercellular fluids from uninjured cells, 0·05 ml. per ml.	0·803	3·00	4·31
Adenosine, 5×10^{-5} molar ..	0·416	3·21	4·50
Muscle adenylic acid, 5×10^{-5} molar	0·488	3·44	4·65
Adenyl pyrophosphate, 5×10^{-5} molar	0·309	3·32	4·85
Same, $2·5 \times 10^{-4}$ molar ..	0·624	3·70	5·52

R = Reader's medium[20].

A = following supplements (γ per ml. of culture): aneurin 0·25, pyrodoxin 0·50, biotin 0·000125, calcium pantothenate 0·125, riboflavin 0·5, choline 0·75, nicotinamide 2·5.

B = following supplements (all 0·625 mgm. per ml. of culture): glutamic acid, asparagine, aspartic acid, leucine, arginine.

The similarity of the spectra of (I) to adenine[14] in (*a*) selective absorption, (*b*) stability to *p*H change, and (*c*) lack of degradation by prolonged ultra-violet irradiation suggested an investigation of the proliferation-promoting effects of various adenine nucleotides. The absorption of (I) was equivalent to an adenine molarity of 5×10^{-4}. In corresponding concentrations, yeast nucleic acid and yeast adenylic acid appeared to be inactive. Adenosine, muscle adenylic acid and adenyl pyrophosphate all stimulated growth, the response with the last being most typical of that with (I) in the growth period up to 24 hours. In all instances, the activities of the nucleotides were much less than that of (I), indicating the presence of other growth factors in (I). Accordingly, the effects of (I), (II), adenosine, muscle adenylic acid and adenyl pyrophosphate were tried in combination with known growth factors and amino acids. The combined supplements, growth factors and amino acids, masked the stimulating effect of (II) but not of (I)[15], as shown in the accompanying table, confirming similar results of Cook[16]. Addition of adenosine, muscle adenylic acid or adenyl pyrophosphate to supplemented media gave increased growth in all instances. The higher concentration of adenyl pyrophosphate plus growth factors duplicated the effect of (I) in growth kinetics and total growth response, and the addition of adenyl pyrophosphate at this concentration to media containing both supplements, growth factors and amino-acids resulted in increased growth somewhat greater than that obtained by addition of (I).

Assays of (I) and (II) for known growth factors[17] showed appreciable quantities of biotin, pantothenic acid, pyridoxine, nicotinic acid and folic acids in (I) but not in (II). Preliminary tests (not regarded as final) for diphospho- and triphosphopyridine nucleotides in (I) were negative[18]. In manometric studies, both adenyl pyrophosphate and (I), but not biotin or yeast adenylic acid, were found to elevate markedly the oxygen uptake and respiratory quotient of growing or resting yeast cells[9], simulating phenomena frequently observed in damaged cells and tissues[19].

Two conclusions appear of particular interest: (1) adenine nucleotides (not hitherto regarded as growth factors) stimulate the growth of yeast in well-supplemented media, and (2) the metabolic effects of suspension fluids from damaged yeast cells are duplicated by combinations of adenine nucleotides and known growth factors. It remains to be determined to what extent the release of known growth factors and nucleotides by injured animal tissue cells plays a part in tissue metabolism and repair following injury.

I wish to thank Dr. Fritz Lippmann, of the Harvard Medical School, for supplying several of the nucleotides and for his kindly interest in the investigations.

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June 26.

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Sexuality in *Dugesia tigrina* (syn. *Planaria maculata*)

Individuals of the striped variety of *Dugesia tigrina* collected in the summer of 1935 in the pond behind the Episcopal Church, Falmouth, Mass., have been maintained in the laboratory in finger bowls containing tap water and have been fed beef liver twice or three times a week. During their seven-year stay in the laboratory they have produced egg capsules annually.

In the spring of 1941 the egg capsules deposited by the members of the original 1935 stock were isolated. The worms (F_1) hatching from them were raised under the same conditions as the parents. During the current spring (1942), these animals (F_1) produced cocoons from which viable worms (F_2) emerged.

Hyman[1] presents the theory that individuals of *D. tigrina* living in quiet water remain asexual and those subjected to a strong current or violent waves become sexual, producing many cocoons[1].

Neither the F_1 nor the F_2 planarians have ever been exposed to any strong current, and their parents and grandparents have lived a quiet, sheltered life for six and seven years respectively.

The data are not compatible with the theory that "moving water is the essential environmental factor in the development of sexuality in *D. tigrina*". This hypothesis could only be tenable were we to concede that the F_1 and F_2 animals become sexual because their ancestors at one time were exposed to moving water. This, the present available facts do not justify.

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The Public Schools in Great Britain

The recent appointment of a Committee on Public Schools by the President of the Board of Education has stimulated much discussion on the function of the public schools. The main object of this Committee is "to consider means whereby the association between the Public Schools and the general educational system of the country could be developed and extended". The Committee's terms of reference imply only a modification of the existing system. It is for this reason that we issue this statement raising the whole question of the existence of the public schools.

The constitutions of the schools included in the Public Schools Year Book vary considerably. In this document we use the term 'public school' to denote those schools which do not receive grants from the Treasury and which are maintained solely by fees and endowments.

Britain is the only great industrial country where wealth systematically buys a different type of education for its offspring; where education sets a different aim for the wealthy than for those less well off. We thus preserve a system in striking contrast to those of the U.S.A. and U.S.S.R., and of those smaller democracies such as the Scandinavian, to whose social institutions we look with admiration.

The system of public school education is undemocratic. It segregates those children who, by inheritance, proceed to leading positions in industry, politics, the civil services, the armed forces, and by its training strengthens their social privileges. It is socially injurious, since it divorces this section of our people from the rest, from the life of the main part of the community, especially from all those engaged in the productive processes and manual and technical labour. Men brought up in the public school tradition are out of touch with modern social realities and often incapable of grasping modern social problems.

The prospect of endowing these schools with Treasury grants is usually linked with a proposal to admit into these schools a limited number of the more gifted members of the poorer sections of society. This proposal is born as much from the financial crisis of the public schools as from an awareness of their social responsibilities. If it were adopted, the main results would be:

(*a*) a direct subsidy given by the taxpayer to the schools of the wealthy;

(*b*) the psychological dislocation of the gifted poor boys, who would thus be in the position of poor relation in the family of the rich;

(*c*) the stultification of the gifts of these hostages, since in this atmosphere they would lose contact with the life and problems of the mass of the people;

(*d*) the intellectual impoverishment of the State-aided secondary schools which would thus lose their most gifted pupils.

However much the study of the natural and social sciences is cultivated in the public schools, the divorce between this type of education and life cannot be overcome. Science under these social conditions tends to become an esoteric cult, isolated from social purpose. If non-scientific subjects are adapted to social ends, the public schools tend to develop into institutions for the training of 'leaders', that is, into political academies for the firmer establishment of the dominance of a class. The type of social conscience thus engendered, and expressing itself in this sort of reform, is undemocratic and reactionary.

Any botching and patching of the existing public school system will necessarily tend, whether or not by intent, to perpetuate present evils and inequality. It is true that some public schools possess, at present, advantages from a technical-pedagogical point of view over State-aided secondary schools. But this is no reason for prolonging their existence in their present form. Let us see their educational methods, their organization and their personnel applied to the service of a wider community than the wealthy.

We do not ignore the fact that State-aided secondary education stands in need of considerable reform. Much adjustment is needed in the matter of school government, of curricula, of social status. Once the dichotomy in our secondary education is overcome a concerted drive for reforms in these fields can be made, undistracted by considerations of social prestige and privilege.

We call, therefore, for the full incorporation of the public schools into a unified, State-aided system of secondary education as a step towards democracy in our educational system and towards greater health in our national life.

J. D. Bernal, P. G. H. Boswell, S. Brodetsky, J. Chadwick, W. E. Le Gros Clark, F. A. E. Crew, C. Lovatt Evans, B. Farrington, C. B. Fawcett, P. Sargant Florence, P. F. Frankland, Lancelot Hogben, Julian Huxley, R. K. Kelsall, R. D. Laurie, Joseph Needham, R. Pascal, J. A. Ryle, F. Soddy, H. G. Stead, Geo. Thomson, F. E. Weiss, F. Wood-Jones.

RESEARCH ITEMS

Structure of Salivary Gland Chromosomes

M. KODANI (*J. Hered.*, 33, 115; 1942) has continued his experiments of treating salivary-gland chromosomes with alkalis. By using urea-alkali mixtures he has been able to produce further changes over and above the lamp-brush effect and thereby arrives at certain conclusions regarding the structure of the normal salivary gland chromosome. Three different series of transformations under treatment were produced and these are shown to result from different modes of migration of part of the nucleic acid from a peripheral position to the chromonemata in the centre of the chromosome. The number of chromonemata per chromosome is definitely four; not polytene as stated by others earlier. Two chromonemata are coiled intimately and in each disk expand laterally; the other two chromonemata coil also and form loops in the opposite direction in each disk. There appears to be a membrane to the chromosome, but whether this is an artefact or a reality is not yet determined although the effect of nuclease treatment would suggest the presence of a membrane in the normal chromosome.

Isolation and Collection of Salivary Gland Chromosomes

J. B. Buck and A. M. Melland (*J. Hered.*, 33, 173; 1942) describe various methods for the preparation of salivary gland chromosomes for analysis by X-ray diffraction and electron-diffraction. Dissection of the chromosomes from cells mounted in egg-albumen or water were feasible but the chromosomes underwent further changes in time. Therefore the chromosomes were first fixed in osmium tetroxide, acetic acid, or formalin sufficiently long to make the nuclear membrane brittle enough to be cracked open. The chromosomes were collected by a micro-pipette and transferred to collodion membrane and centrifuged to Pyrex glass capillaries. Preparations of 6,500 nuclei, 1,000 nuclei and 800 nuclei respectively were photographed by X-ray diffraction methods without success. Electron diffraction of mounted chromosomes gave one ring of 3·4 A., which is suggestive. A block of chromosomes orientated in parallel fashion containing 1,253 chromosomes and measuring 0·25 × 0·25 × 0·05 mm. were photographed by Dr. W. T. Astbury. X-ray diffraction results again gave suggestive effects. The technique, when developed, will be useful in future work.

Lower Devonian Plants

NEW and rich fossil localities discovered in the Senni Beds of Monmouthshire and Breconshire have yielded the most extensive and representative flora of late Lower Old Red Sandstone age in Britain (W. N. Croft and W. H. Lang, *Phil. Trans. Roy. Soc.*, B, 131, ; June, 1942). The specimens are represented by thin incrustations or by impressions, hence the information afforded is mostly relative to external morphology. The remains of a spiny plant of *Psilophyton princeps* type have a hitherto undescribed fructification in organic connexion with the vegetative shoots. This fructification is quite unlike Dawsonites of which typical examples also occur. Numerous specimens of Gosslingia have shown that the sporangia were not borne on special fertile branches as was originally supposed but on the margins of the regular dorsiventral branch system. Zosterophyllum is divided into two subgenera, one with radial spikes and a new species with dorsiventral second spikes of sporangia. Good examples of Cooksonia continue this type from the Downtonian to the Senni Beds, while Sporogonites, Sciadophyton and Taeniocrada are recorded for the first time from British rocks. Prototaxites and Nematothallus occur along with the vascular plants, and Pachytheca is represented in several exposures.

New Species of Fungi

SEVERAL descriptions of new species of fungi have recently appeared (*Trans. Brit. Mycol. Soc.*, 25, Pt. 3; June, 1942). T. Petch, in his continued studies on entomogenous fungi, finds new taxonomic units in *Calonectria truncata*, from leaf hoppers in the West Indies, *Hymenostilbe aphidis*, also from the West Indies, *Isaria* (*Beauveria*) *sphærocephala* from lepidopterous larvæ in Ceylon, and *Cephalosporium subclavatum* from similar larvæ in Great Britain. Elizabeth G. Gray has described *Phialea mucosa* as a new species. It appears to be the cause of blind spot disease of rye-grass, a malady originally studied by Neill and Hyde in 1939.

Gravity Measurements in Guatemala

AT the suggestion of E. G. Zies of the geophysical laboratory of the Carnegie Institution of Washington who is working on the volcanoes Santa Maria and Santiaguito, F. E. Wright has made gravity measurements in the neighbourhood of the volcanoes ("Gravity Measurements in Guatemala", by F. E. Wright. Geophysical Laboratory, Carnegie Institution of Washington, 1941, No. 1049). It was suggested that if a network of accurate gravity stations were to be established in the Santa Maria volcano region and the measurements were repeated at these stations periodically, changes in the values of gravity at the stations might serve to indicate the migration of the molten rock below the volcano towards the surface. In establishing each gravity station of the series its exact elevation was determined in order that, if a change in the observed value of gravity were obtained at a given station, it would be possible to ascertain if the change were due to uplift or downwarp of the surface at that point or to a shift in underlying rock masses and the upward movement of the molten mass. Magnetic and other measurements were made for comparison with the gravity measurements. The gravity measurements were made with a Brown gravity pendulum loaned by the United States Coast and Geodetic Survey and a base station was occupied at Washington. Numerous difficulties were encountered, notably in connexion with the radio time signals on account of interference, and the flexure of the basement floor of the observatory, but the following results were obtained, previous results being given for comparison:

Station	Observer	Year	Gravity gals.	Elevation metres
Guatemala City	Pedro Sanchez	1935	977·973	1,494
	Shell Company	1938	977·986	1,494
	F. E. Wright	1940	977·985	1,494
Quezaltenango	F. E. Wright	1940	977·781	2,384

Drifting Force on a Ship among Waves

WHEN a ship is advancing through a train of waves it experiences an average steady resistance greater than that at the same speed in smooth water. Study of the wave pressure due to the reflexion or scattering of the ocean waves of the surface of the ship involves second-order terms in the hydrodynamical equations. A solution is difficult but approximate calculations appear to show that the effect would account for a small fraction only of the total effect. T. E. Havelock continues his researches upon the subject by making tentative calculations associating the effect directly with the oscillations of the ship (*Phil. Mag.*, 33, 467; 1942). A steady average drifting force is obtained depending upon the phase differences between the heaving and pitching motions and the periodic forces and couples due to the wave motion. Although the available experimental data are not suitable for detailed comparison, the calculations give drifting forces of the same order of magnitude.

Stress Distributions in Solids of Revolution

THE theoretical determination of stress distributions in such complete solids of revolution as twisted shafts of non-uniform diameter, axially symmetrical pressure vessels and in incomplete tores such as helical springs of small pitch, beams of large curvature or hooks is extremely difficult by orthodox methods on account of the boundary conditions. Recent extensions of the relaxation method have gone far to remove the difficulties, and lately trial has shown them to be surmountable. Consequently, the analysis has now acquired utility and has been given by R. V. Southwell (*Proc. Roy. Soc.*, A, **180**, 367; 1942) as a background to papers in course of preparation. The 'semi-indirect' method of Saint Venant is applied to determine directly, that is, without explicit reference to strains, the stress distributions in these solids. As the paper is intended as a prelude to approximate but general treatment of relaxation methods, only simple examples are given, but a comparison is made with earlier solutions less suited to a 'relaxation' approach.

Thermal Vibrations and Scattering of X-Rays

M. BORN continues his studies of the subject in a third paper (*Proc. Roy. Soc.*, A, **140**, 397; 1942). C. V. Raman's explanation of the diffuse scattering is compared with the 'thermal' theory which in its revised forms satisfies the demand of a theory based on quantum principles. The relationships of the dynamical matrix, describing the mechanical properties of the lattice and the scattering matrix, describing the scattering power are discussed, together with the influence of the ordinary Raman effect on the scattering.

Spectrographic Observations at the Total Eclipse of October 1, 1940

R. O. REDMAN has prepared two papers on this subject (*Mon. Not. Roy. Astro. Soc.*, 102, 3; 1942), the first of which, "Instrument and Observational Procedure", is summarized in the present note. The second paper is only the first of a series dealing with spectrographic observations. The author was with the eclipse party at Calvinia. It is interesting to notice that a correction was made to the tabular longitude of the moon of 0·8″ instead of the *Nautical Almanac* value 2″ and, in spite of this better value, totality came more than 3 seconds earlier than the predicted time. A number of suggestions and also some criticisms are offered for the advantage of those who may make observations with similar, though improved apparatus, at eclipses in the future. Among these may be noted the suggestion that the cœlostat drive should be rated to follow the moon. The cœlostat and concave mirror mountings should be mounted substantially; it was found that the mount for the concave mirror at Cavinia vibrated even in a gentle breeze, and it was necessary to load it heavily with bricks. A mechanical drive rather than the hand drive is recommended for the camera; however skilful and careful the operator may be, a hand drive cannot give the regularity of a machine. Instead of starting exposures by using the computed time, it seems possible that better results would be obtained by estimating the time from the size of the disappearing crescent just before second contact. The success of the pit made for the instruments requiring thermal protection suggests this method for future eclipses, provided local conditions are suitable.

Recent Changes in the Spectrum of γ Cassiopeiæ

MISS E. M. PEACHEY has described the changes in the spectra of γ Cassiopeiæ obtained on thirty-five plates taken at the University of London Observatory between July 8 and November 22, 1940 (*Mon. Not. Roy. Astro. Soc.*, 102, 3, 1942). During this period, the hydrogen lines of the Balmer series varied from very sharp, strong absorptions with faint emission borders to broad, fainter, diffuse absorption lines. Similar variations were observed, but to a much smaller extent, with the lines of Helium I. A plate shows eighteen spectra which have been selected as typical and it includes two additional spectra taken during the summer of 1939. The latter show the transition from the emission-line stage to the sharp absorption stage. A certain amount of detail which was visible on the original negative has been lost in reproducing the plate, but the changes described in the paper are easily seen. One particular feature shown on the plate is the general broadening of the lines and their subsequent narrowing on November 19 and 20 before they returned to normal on November 22. A summary of the observed changes in the spectrum is given and it is suggested that more plates, obtained with an instrument of higher dispersion, should be taken when rapid changes in the star are noticed.

Sunspots during 1938

A PAPER on the mean areas and heliographic latitudes of sunspots during 1938 has been communicated by the Astronomer Royal to *Mon. Not. Roy. Astro. Soc.*, 102, 3, 1942, and is a continuation of earlier results. (*Mon. Not.*, 100, 495, 1940). The measurements of photographs taken at the Royal Observatories of Greenwich and the Cape and at the Kodaikanal Observatory, India, were conducted at Greenwich, and the results are given in four tables. The years 1937–38 constitute a notable sunspot maximum compared with the outstanding peak of 1870 (Kew photographs) and those of 1837, 1788 and 1778 (Wolf's numbers). In 1938 the southern hemisphere showed greater activity in contrast with 1937, when the northern hemisphere was more active. During 1938 there were thirty spots which were not less than 500 millionths of the sun's hemisphere in mean area, and of these, nine were of mean area greater than 1,000 millionths. One of these great groups had a mean area of 2,955 millionths and was the second largest group ever recorded at Greenwich. The latitudes for individual spots ranged from 0·7° to 45·6°, and the mean latitude of all spots weighted according to area was 14·8°. The mean latitude thus continues the equatorward progression of the mean spot belt in the two hemispheres during the eleven-year cycle. The above figures are based upon two one-day spots, but the range was found to be from 1·8° to 42·1° for spots of duration not less than two days.

THE LEAGUE OF NATIONS

A REPORT on the work of the League of Nations, 1941–42, which has been submitted by the Acting Secretary-General, well indicates the valuable contribution which the League should be able to make to the solution of problems of reconstruction, European relief, and the like, apart altogether from whatever value its organization and machinery may possess as a starting point for a fresh attempt to organize peace and to plan international co-operation.

Dealing first with economic, financial and transit questions, the report notes that the League's World Economic Survey, its Statistical Year-book and the *Monthly Bulletin of Statistics* have been maintained, and while the headquarters at Geneva have specialized on European developments, the part of the Economic, Financial and Transit Department sent on mission to Princeton follows the course of events in the rest of the world. In addition to the three pivotal publications already mentioned, the Secretary-General proposes to publish this year the statistical part of the work previously published in two volumes under the title "Money and Banking".

In regard to post-war economic problems, the programme visualized for 1942 is guided by three principles. Since the future must be built on the past, it is essential before planning and projecting that building to ascertain the causes of success or failure in the recent past, and to learn and apply the lessons which may be deduced from the past. Secondly, such evidence must be supported by an adequate basis of fact, the relevant information being collated and analysed to assist those responsible for the formulation of policy to frame their own judgment on them. Thirdly, the care of the social and economic issues of the future is likely to be the problem of social security, and the means by which control of the two groups of dynamic forces at present discernible in modern society may be rendered effective should therefore constitute the central thread of all constructive thinking for the future, and all future policies must be considered in the light of their probable effect on economic stability, on demographic conditions, and on social security. The programme includes commercial studies, one of which, "Europe's Trade", has already been published, studies on raw materials such as obstructions to free access, control schemes, raw-material shortages and surpluses at the end of the War of 1914–18 and on proposals to secure equal conditions of supply or prevent violent fluctuations in price, as well as on the whole experience of relief and reconstruction. In regard to agriculture, a careful study is being made of current agricultural developments in war areas and elsewhere. International currency problems, economic depressions and social security and demographic questions are also receiving attention, as well as transport in relation to post-war relief and reconstruction and the preparatory examination of the future international organization of transport. A full programme of studies on European demographic problems is outlined in the report.

In regard to social and humanitarian questions, the Secretary-General's report describes the way in which the Health Section continues to deal with questions of epidemic disease. The service of Epidemiological Intelligence and Public Health Statistics has continued, with interruptions, and Singapore Bureau has now been re-opened in Australia, where it is carrying on within the limits imposed by war conditions. The *Weekly Epidemiological Record* has appeared regularly at Geneva without any interruption and an annual Epidemiological Report was distributed at the end of 1941. The standardization of sera and of vitamins has continued, and results of the latest research conducted under the Commission were published in 1941 in the *Bulletin of the Health Organisation*. The Health Section is also endeavouring to ascertain the effect of food rationing on the general level of health of European populations, and has supplied information on numerous health questions such as the effect of the War on the health situation, typhus, tuberculosis, feeding and nutrition, etc.; reference is made to the future opportunities for action which the field of nutrition appears to offer the Health Organisation.

Activities in regard to the control of the drug traffic have been essentially maintained, and the Permanent Control Opium Board continues to watch the international trade in narcotic drugs on the basis of statistical information supplied by Governments. The Child Welfare Information Centre has been maintained and intellectual co-operation has continued in the United States, where the national committees of that continent held their second conference at Havana in November 1941. The programme included the examination of the basic principles upon which intellectual co-operation depends: improvement of copyright regulations; removal of obstacles to cultural and intellectual exchange, such as high duties on books, excessive postal rates. International assistance to refugees is being continued on the lines laid down by the Assembly in September 1938, and brief reference is made to such matters as mandates, slavery, the protection of minorities and the registration of treaties where the League's administrative work has been interrupted or restricted by the War.

The report includes an analysis of the League's budget and of the reduction in the staff of the secretariat, but gives an encouraging and indeed surprising picture of the maintenance of economic, social and humanitarian activity and of the conservation of reserves in readiness for the resumption of co-operation and the handling of reconstruction problems.

MAN-POWER IN THE NATIONAL FIRE SERVICE

IT seems clear, from the thirteenth report of the Select Committee on National Expenditure, dealing with the National Fire Service, that the administration of the Service is already under close scrutiny from within, and that active steps are already being taken to discover ways and means of simplifying the administration and reducing the staff. Centralization of the administration at area headquarters requires speeding up in urban areas, while in rural areas decentralization is the recommended policy, with a more direct connexion between region and division. Amalgamation of some of the administrative posts, such as establishments and stores, appears to be possible, and experience in Scotland should provide a useful guide as to some of the possibilities in this direction.

The question of man-power is one of the major problems considered by the report. Partly it is approached from the point of view of utilizing in some effective way the time of the men who are standing by, and the report recommends that the fullest use should be made of the skilled men in the Service by the setting up of workshops for the repair of motor-vehicles and also for the repair of uniforms.

While the report recommends that the practice of allowing men on duty to do some industrial work at their stations should be encouraged and expanded at once to the utmost extent possible without interfering with their routine duties and training, the attitude of the Select Committee on this question is similar to that of Mr. Morrison as indicated in his speech on July 30; neither seems to realize the very serious problem of man-power which is involved and is likely to increase in gravity. The Committee's objection to the 24–24 hour system that such a practice may not be good for the Service, as a man may very easily become more interested in his civilian job, can scarcely be taken seriously in the present situation. If a uniform system of hours is to be adopted for the whole country, as the Committee recommends, the effects of the 24–24 hours system with the men directed to eight-hour factory shifts on their days off during lulls, as is being attempted in the north-west of England, should be examined.

Somewhat surprisingly, the other aspect of this question of hours and of the importance of alternative occupation is rather overlooked by the Committee. The report shows little appreciation of the real dangers to efficiency which arise from keeping men too long confined to their stations, and insufficient attention is given to welfare work in the National Fire Service. The Committee in fact scarcely appears to realize that the troubles of the National Fire Service spring chiefly from long periods of inaction and the failure to divert or occupy its members; indeed it suggests that welfare should be primarily the responsibility of the various commanding officers, assisted by the establishment officer, and it is recommended that welfare officers should not be specially appointed. Probably officers who can find leisure occupation for the men and watch over their conditions of living, eating and sleeping are the greatest need of the National Fire Service to-day. Moreover, although a wide view of welfare not limited to sporting activities is taken, nothing is said on the question of educational service. That has still to receive official encouragement; indeed in London, where it was commenced by the men, it was for long hindered rather than helped, and other regions have nothing of the kind. Nevertheless, the need of the Fire Service for educational service is just as great as that of the Army, where its value has long been recognized.

There are few ways in which the local authorities could better display their interest in the fire service now that it has been nationalized. The health and cultural welfare of this body of men, their own citizens, though now serving in a national force, gives a great opportunity. They could do much to support educational schemes, even if they cannot assist in their initiation, and to demand and maintain good living conditions. Whatever advantages there may have been in a local service with its fuller knowledge of local conditions could at least be utilized in welfare work, with benefit in efficiency and morale.

To bring to concert pitch, adequately but not overstaffed, such a force as the National Fire Service, and to maintain that efficiency over prolonged periods of inactivity, demand inspired leadership alive to the human issues as well as to the technical problems involved.

CONTACT RESISTANCE

THE effects of contact resistance on temperature rise in switches are examined by R. W. J. Cockram in the *Electrical Review* of August 21. A factor complicating the control of electric circuits is the contact resistance set up between two mating surfaces of metal which at times have to be separated in order to break continuity of supply. The two main methods of decreasing contact resistance—excluding the use of special contact tips—are to increase the contact area and to increase the contact pressure. Contact pressure can be increased only to a certain limit, beyond which it results in a welding-in of contacts. Large contact surfaces are uneconomical; they are, in fact, made as small as possible consistent with a contact pressure low enough to preclude welding-in.

Knife type contacts depend mainly on large contact-surface area rather than high mating surface pressures to maintain low resistance values. Unless enclosed they are operated only under no-load conditions, and should not be worked in excess of 500 amp./sq. in. Point butt-type contacts mainly find application on instrument-control switches, control-circuit contacts or interlocks on contactor gear. Rarely rated above 5 amp. at 440 volts, their contacts are usually of silver and take the form of portions of spheres, two breaks in series being employed. A slight 'wiping' action takes place which assists oxide removal. Line butt-type contacts are also chiefly associated with contactor apparatus. In these, heavy pressures are applied, generally to the main poles of contactors up to 150 amp. with spring pressures of 8–10 lb./sq. in. Replaceable contact tips are used, and a degree of wiping is provided. Surface type contacts call for complete mating of the contact surfaces; each moving contact is divided into four segments, each segment being acted upon by two springs. Taper-butt surfaces are employed for the control of heavy currents, as in circuit breakers and similar equipment.

In all the forms of contacts cited, pressure is applied to the mating surfaces. Some small degree of spot welding may be permitted while the wiping action is sufficient to break it; it is, however, best prevented. Burning and pitting was at one time considered to take place during the breaking of circuits but it is now mainly attributed to imperfect mating over long periods in the engaged position, the resulting oxidation causing further heating. Silver contacts are accordingly used, giving a greater working life since silver oxide is a comparatively good conductor.

MAGNETIC FLUXMETER

MEASUREMENT of magnetic field strength due to current in a coil is usually made by changing the current and observing the voltage induced in a search coil or in the coil itself. This voltage is proportional to the rate at which the magnetic flux varies and it fluctuates in magnitude and direction, if the field pulsates or alternates. For rapid flux alternations a galvanometer will show no deflexion, but a steady reading can be obtained if the galvanometer connexions are reversed as the induced current reverses. The deflexion is then a measure of the magnetic field under observation. A practical application of this method is the measurement of voltage induced in a relay by the operation of a neighbouring relay.

A fluxmeter working on these principles has been developed in the Bell Laboratories and is described by E. L. Norton (*Bell Lab. Rec.*, 20, No. 10; June, 1942). It has a pulse generating device operating high-speed relays which reverse simultaneously the current producing the flux and the meter connexions. Pulse rates of 30, 15, 7·5 and 3·75 per sec. are obtained from gas tube discharges as submultiples of 60-cycle alternating current. The measuring circuit includes a bridge which is used when flux is measured by the voltage induced in the coil itself. Switching is so arranged that, when not pulsing, the bridge may be balanced using the indicating meter as a galvanometer. A loss pad is incorporated enabling the meter to read one third- or one tenth of the actual current. This apparatus gives readings more conveniently and accurately than previous magnetic fluxmeter readings usually made with a ballistic galvanometer. In addition, it has the added advantage of being suitable for adaption to a portable construction.

FORTHCOMING EVENTS

Tuesday, September 22

INSTITUTE OF PHYSICS (at the Royal Institution, Albemarle Street, London, W.1), at 11 a.m.—Discussion on "The Determination of Equilibrium Diagrams by X-Ray Methods". (Opening speakers: Dr. A. J. Bradley, F.R.S., Dr. W. Hume-Rothery, F.R.S., Dr. M. L. V. Gayler, Prof. E. A. Owen.)

Wednesday, September 23

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 2.15 p.m.—Presidential Address. Mr. H. Rottenburg: "Publishers and the Universal Decimal Classification".

Saturday, September 26

SOCIETY OF CHEMICAL INDUSTRY (JOINT MEETING OF THE MANCHESTER SECTION AND THE FOOD GROUP) (in the Reynolds Hall, College of Technology, Manchester), at 2.30 p.m.—Dr. L. H. Lampitt: "The Preservation of Foodstuffs".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DRAINAGE ENGINEER to the Hampshire Rivers Catchment Board—The Clerk to the Board, The Castle, Winchester (September 28).

DIRECTOR OF THE CHEMICAL RESEARCH LABORATORY, TEDDINGTON—The Secretary, Central Register (Ref. F690), Ministry of Labour and National Service, Sardinia Street, Kingsway. London, W.C.2 (September 30).

TEACHER OF ELECTRICAL ENGINEERING—The Principal, Wolverton Technical College, Wolverton, Bucks. (October 3).

LECTURER IN PHYSIOLOGY—The Principal, Liverpool Physical Training College, Barkhill Road, Liverpool 17.

GRADUATE LECTURER with good Honours or higher qualifications in MATHEMATICS—The Principal, Neath Mining and Technical Institute, Neath, Glamorgan.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Health. First and Second Interim Reports of the Medical Personnel (Priority) Committee. Pp. 12. (London: H.M. Stationery Office.) 2*d.* net. [89

Reports of the Progress of Applied Chemistry. Vol. 26, 1941. Pp. 545. (London: Society of Chemical Industry.) [89

Scottish Society for Research in Plant-Breeding. Report (abridged) by the Directors and Report by the Director of Research to the Annual General Meeting, 16th July 1942. Pp. 34. (Edinburgh: Scottish Society for Research in Plant-Breeding.) [89

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Plant Illustration from Woodcut to Process Block: Handbook to a Temporary Exhibition, based on the Collection in the Department of Botany, July–December 1942. By A. E. Wade. Pp. 32. (Cardiff: National Museum of Wales.) 3*d.* [89

Medical Research Council: Industrial Health Research Board. Emergency Report No. 3: The Personal Factor in Accidents. Pp. 20. (London: H.M. Stationery Office.) 4*d.* net. [89

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 9: Notes on some Lepidopterous Pests on Fruit Trees, and their Parasites, in Ireland during 1941. By Dr. Bryan P. Beirne. Pp. 107–118. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.), 1*s.* [89

Imperial Bureau of Soil Science. Technical Communication No. 41: The Take-All Disease of Cereals. By S. D. Garrett. Pp. iii+40. (Harpenden: Imperial Bureau of Soil Science.) 2*s.* 6*d.* [89

Scientific Proceedings of the Royal Dublin Society. Vol. 22 (N.S.) No. 49: Salmon of the River Erne—Results of the Examination of a Small Collection of Scales and Data. By Arthur E. J. Went. Pp. 471–480. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s.* [89

Civil Service Reform: the Interim Report of the Sub-Committee on the Reform of the Civil Service appointed by the Industrial and Social Reconstruction Committee of the Liberal Party. Pp. 16. (London: Liberal Publication Department.) 3*d.* [99

Infant and Maternal Mortality in relation to Size of Family and Rapidity of Breeding: a Study in Human Responsibility. By C. M. Burns. Pp. viii+247. (Newcastle-upon-Tyne: King's College Medical School.) 5*s.* [109

Other Countries

Bulletin of the American Museum of Natural History. Vol. 79, Art. 7: Results of the Archbold Expeditions, No. 43: Birds of the 1938–1939 New Guinea Expedition. By A. L. Rand. Pp. 425–516. Vol. 79, Art. 8: Results of the Archbold Expeditions, No. 44: Some Notes on Bird Behavior. By A. L. Rand. Pp. 517–524. (New York: American Museum of Natural History.) [278

Proceedings of the United States National Museum. Vol. 92, No. 3145: Notes on Beetles related to *Phyllophaga* Harris, with Descriptions of New Genera and Subgenera. By Lawrence W. Saylor. Pp. 157–165+plate 17. Vol. 92, No. 3146: Descriptions of the Larvae of some West Indian Melolonthine Beetles and a Key to the Known Larvae of the Tribe. By Adam G. Böving. Pp. 167–176+plates 18–19. (Washington, D.C.: Government Printing Office.) [288

Bericht über das Geobotanische Forschungsinstitut Rübel in Zürich für das Jahr 1941. Von E. Rübel und W. Lüdi. Pp. 37+2 plates. (Zürich: Geobotanische Forschungsinstitut Rübel.) [288

Agriculture and Animal Husbandry in India, 1938–39. Pp. v+422+10 plates. (Delhi: Manager of Publications.) 6 rupees; 6*s.* 9*d.* [89

Consejo Superior de Investigaciones Científicas: Instituto Nacional de Geofísica, No. 3 (Memorias del Observatorio del Ebro, 8): Contribución al estudio general del problema de la repetición de los eclipses. Por Dr. José Mª Torroja Menéndez. Pp. 98. (Tortosa: Libreria de Algueró y Baiges.) [89

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 23, No. 31: Notes on a Collection of Reptiles and Amphibians from Guatemala, 2: Lizards. By Joseph R. Slevin. Pp. 453–462. Vol. 23, No. 32: Notes on a Collection of Reptiles from Boquete, Panama, with the Description of a New Species of Hydromorphus. By Joseph R. Slevin. Pp. 463–480+plates 39–42. (San Francisco, Calif.: California Academy of Sciences.) [89

Indian Forest Bulletin No. 111 (Utilisation, New Series): Cheap and Simple Types of Tanks for the Treatment of Timberby the Dipping, Steeping or Open Tank Process. By Dr. D. Narayanamurti. Pp. iii+3+6 plates. (Delhi: Manager of Publications.) 6 annas; 7*d.* [89

Publications of the Dominion Observatory, Ottawa. Vol. 13: Bibliography of Seismology, No. 11: Items 5280–5356, January to June, 1942. By Ernest A. Hodgson. Pp. 189–200. (Ottawa: King's Printer.) 25 cents. [89

Canada: Department of Mines and Resources: Mines and Geology Branch, Geological Survey. Paper 42–1: Preliminary Map, Mansonville, Quebec. By J. W. Ambrose. 10 cents. Paper 42–2: Second Preliminary Map, Manson Creek, British Columbia. By A. H. Lang. 10 cents. Paper 42–3: Marble Mountain Map-Area, Alberta (Summary Account). By H. H. Beach. Pp. 15+map. 10 cents. Paper 42–4: Brock River Map-Area, Abitibi and Mistassini Territories, Quebec (Summary Account). By E. D. Kindle. Pp. 7+map. 10 cents. Paper 42–5: Preliminary Map, Cypress Lake, Saskatchewan. By G. M. Furnival. 10 cents. Paper 42–6; Preliminary Map, Princeton, British Columbia. By H. M. A. Rice. 10 cents. Paper 42–8: Preliminary Map, Bassano, Alberta. By J. S. Stewart. 10 cents. Paper 42–10: Preliminary Map, Eastmain, Quebec. By G. Shaw. 10 cents. (Ottawa: King's Printer.) [89

Catalogues

ST'R Electronic Controls. (AH-243.) Pp. 4. (London: L.A. Steiner).

A Supplement of Scientific Books. (No. 17*c*, 1942.) Pp. 12. (Cambridge: W. Heffer and Sons, Ltd.)

Gestyl Organon: Gonadotrophin of Pregnant Mare Serum. Pp. 6 (London: Organon Laboratories, Ltd.)

General Catalogue. (Catalogue No. 663.). Pp. 74. (London: Francis Edwards, Ltd.)

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PROBLEMS OF PERSONNEL IN PUBLIC SERVICES

THE problem of personnel in the Civil Service and other public services cannot be considered altogether apart from the nature and range of the work which the post-war public services will be called upon to do, and this in turn is affected by the nature of the social and economic structure of the country. It is not only that free migration and interchange both between the national and municipal services and between these and the public or semi-public corporations is much to be desired, but rather that the essential social structure of the community and the relative importance of the service and the profit motives have important repercussions. It must obviously influence the underlying philosophy of the Civil Servant, whether the source of his inspiration be integrity and tendency to play for safety as in the past, or that more difficult part now needed of reconciling integrity and firmness of administration with the acceptance of responsibility and the capacity for co-ordinated initiative; the character of the new machinery of government is also of fundamental importance. However far that passion for excellence insisted upon by Lord Haldane may sway a reconstructed Civil Service from top to bottom, it will not function with the desired efficiency unless the machinery of government itself is adapted to the new demands. Without any disparagement of a Service which has deservedly earned itself a unique reputation throughout the world, it is clear that adjustment, both of the personnel and of methods of working, is required to meet present and future problems.

Consciousness of this lies behind the views which have openly been expressed in the Press regarding Treasury control and the 'head' of the Civil Service, arising out of the appointment of a new Permanent Secretary of the Treasury. The real point at issue is that of the establishment control stressed in the Haldane report, later in that of the Tomlin Commission and still more recently in a P E P broadsheet. The headship of the Civil Service is an office of great and increasing importance, but it can no longer be usefully combined with the office of Permanent Secretary to the Treasury. The interest in war-time of getting a job done quickly and efficiently, the question of cost being subordinate, is at last compelling recognition in the Civil Service of the principles of staff management as it is understood and practised in modern industry.

Establishment problems are inherent in every form of complex industry and are the regular currency of industrial and business management. Moreover, though it would be rash to assume that all the solutions found successful in the competitive world are applicable to the organization of the Civil Service of Great Britain, the fact that no large concern has found the successful management of its establishment compatible with a close union of staffing and financial functions cannot be disregarded. Cost and economy are considerations fundamentally distinct from those of efficient staff control, the object of which is to see that the right men are found for each job, and then that the conditions of their work are such as to offer the least hindrance to their doing the best that is in them. This is the main test of efficient selection, training, remuneration, promotion, welfare, retirement, or replacement problems, and in these allied questions of the development of efficient methods of working which constitute the essential staffing problems.

The attention which has been directed to such matters in that highly suggestive American report of the President's Committee on Administrative Management should be given careful consideration. Although much of the report is concerned with those problems of the machinery of government which are peculiar to the American constitution, there are sections of profound interest at the present time when the British machinery of government is under examination, and especially in connexion with the nature and extent to which Government control may have to be extended after the War and the manner in which such control should be exercised. Notably is this true of the comments of the report on staff matters and those fundamental principles of administration which are germane to any modern efficient organization.

One of the most important recommendations of this authoritative committee is the development of functional investigation and research into administration problems as a regular aid to management. "Economy and efficiency in government", says the report, "require constant investigation and reorganization of the administrative structure. It is a mistake to assume that government can be reorganized once and for all. A continuous study of the administrative organization of the huge Federal machine is necessary. New activities are constantly emerging and old activities are constantly changing, increasing or disappearing. Unless there is a special agency equipped to investigate problems of organization, new activities are set up without careful attention as to where they should be located and what kind of organization is required. On the other hand, when the need for certain government activities declines or disappears, unless there is a special agency constantly studying the organizational requirements, adjustments are made late or not at all."

The application of this argument to British conditions needs no further emphasis, and the fate of the Haldane report, to which this President's Committee's report is the American counterpart, though on a larger scale, is sufficient warning of the danger of continued neglect. In addition to the establishment of a Civil Service Administrator and a Civil Service Board to handle matters of recruitment and management of personnel, the report urges that a division of administrative research in the Bureau of the Budget is the logical place to develop these functions, and it is clear from the outline of the functions of the Division given in the report that the President's Committee has very clear ideas as to the Division's independence and freedom from defects which characterize Treasury control in Great Britain.

"The Division", says the report, "should stimulate the continuous study of organization, methods of procedure, at the departmental or bureau level by the Departments and Bureaux themselves. It should engage in such studies on its own initiative where necessary but should follow the policy of aiding and encouraging the Departments in the study of their own organization procedural problems. It should endeavour to develop principles of organization that have general applicability and to act as a clearing house, consultation centre for administrative research regarding the Department. Persons engaged in administrative research should be free from routine duties involving handling budget estimates. The administrative research activity should be concentrated in a separate division of the Bureau of the Budget. It should be headed by a permanent chief possessing in unusual degree imagination, vision, creativeness and analytical insight as well as intimate acquaintanceship with both the practices of government and the principles of public administration. The research division must be staffed with persons of unusually high competence. Important research assignments upon administrative problems can be carried out successfully only by highly trained and experienced persons familiar with the organization techniques of public administration."

The sanity and breadth of vision of this admirable report should earn for it widespread attention in Great Britain. Government, in its view, is a 'going concern', not a static institution. New activities should be organized on the basis of purpose, so that purpose may be the central driving force of the organization. While, however, new purposes cannot be achieved without broad freedom to experiment, when an activity is organized, its major policies established, its purposes accepted and understood, and its work in the main placed on a routine basis, the activity should be brought into the normal structure of organization and under the normal conditions.

The bearing of these observations on government problems in regard to reconstruction agencies is quite clear ; those on the human aspects of government and the note that reorganization should be approached as a problem of morale and personnel fully as much as a task of logic and management are equally important. Nor are they irrelevant to the organization of the war effort. Honesty and courage alone are not enough for victory, either in peace or in war. Intelligence, vision, fairness, firmness and flexibility are required in an assembled competent strong organization of democracy. Strong executive leadership is essential to democratic government to-day—on that point there is complete unanimity among critics of H. M. Government both in the field of strategy and in that of production, and the American report urges that the forward march of American democracy at this point of its history depends more upon effective management of all its multitudinous activities than upon any other single factor.

From that opinion there will be no dissent. It is equally true in Great Britain, even when we remember that management is a servant, not a master, a means, not an end, a tool in the hands—and for the purposes—of the people. There can be no doubt that, as the two democracies continue to get "mixed up" in their affairs, in Mr. Churchill's phrase, their outlook and motives must interact powerfully on one another. The report of the Committee on Administrative Management will not pass unnoticed in Great Britain.

In a recent House of Lords debate Lord Portal endorsed Lord Reith's remarks about the importance of efficiency in the Civil Service. His statement was largely an outline of the procedure being adopted by the Ministries concerned with post-war reconstruction, but he agreed as to the importance of right timing in handling these matters, and that the necessary schemes for public services should be ready to put into operation at the appropriate time.

Without going into the details of the arrangements outlined by Lord Portal, it is clear that the Government is not unmindful of the importance of the machinery of government and the efficiency of administration. Nothing must be allowed to interfere, for example, with the handling of the transport question so that the greatest transport resources are brought to bear and used most efficiently during the War, but while any effective solution to transport problems is bound, as Lord Portal pointed out, to be controversial, the Ministry of War Transport is preparing its own scheme of reconstruction. Similarly, the Paymaster-General is examining the reorganization of electricity from the point of view of introducing a better diversity of load, greater standardization of voltage and uniformity of charges, adoption of a common policy with regard to development, and placing the best engineering advice at the disposal of all distributors. Water, which comes under the Ministry of Health, gas under the new Ministry of Fuel, Light and Power, and the location of industry under the Board of Trade, are other matters on which reports are at present being collated and submitted to a ministerial committee over which the Paymaster-General presides.

Lord Portal's statement will almost certainly reinforce the plea for wider powers for the new Ministry of Planning. The functions of the Ministry of Works and Buildings are only a section of those which require central co-ordination and direction, and though there are encouraging signs in Lord Portal's statement, the trend of the debates on war production and other matters in which the organization of government is of prime importance does not indicate that the Government in Great Britain has yet taken to heart the arguments so cogently advanced in the United States. It is to be hoped that the increasing contact with the United States and the constructive criticism of the Select Committee on National Expenditure and other bodies may not fail to have their due effect, and will lead to the adoption of the most effective tools and machinery to implement the national effort, no matter what departmental interests or traditional views may bar the way.

RELATIVITY ON PARADE

Introduction to the Theory of Relativity

By Prof. Peter Gabriel Bergmann. (Prentice-Hall Physics Series.) Pp. xvi+287. (New York: Prentice-Hall, Inc., 1942.) 4.50 dollars.

THE number of systematic treatises on relativity is not unduly large. This is partly because, since the first few years after Einstein's announcement of the 'general' theory in 1917, it has undergone no fundamental development, and partly because the early expositions were so good. One cannot forbear mentioning those of Eddington, von Laue, Pauli, and Weyl. But these were addressed mainly to professionals, and, in spite of subsequent accounts from various points of view, there is still room for a plain text-book suitable for undergraduates reading relativity as a special subject, or for research students needing a working knowledge of it. Prof. Bergmann's book is designed to meet such requirements.

The book is in three parts. The first constitutes a fairly comprehensive account of 'special' relativity; it includes an introduction to tensor calculus, and the theory itself is presented in tensor form. The second is a concise account of 'general' relativity; it consists mainly of a general study of the field equations and an account of standard rigorous solutions in special cases, together with a brief account of the experimental tests of the theory, and a sketch of recent work by Einstein, Infeld and Hoffmann showing how the field equations determine the equations of motion. The third is an introduction to 'unified' field theories, that is, those which incorporate also electromagnetic phenomena in a geometrical system as general relativity incorporates gravitational phenomena in its geometry; after an outline of Weyl's gauge-invariant geometry, it provides a formulation of five-dimensional theory which can be applied to projective field-theories, to Kaluza's theory, and to extensions of the latter in which the author has been a recent collaborator with Einstein.

As is to be expected of a book commended in a foreword by Prof. Einstein, it has many admirable and exceedingly valuable features. But it is relativity on parade, a well-ordered march-past of selected units beautifully turned out in parade dress. It is *not* relativity in action, perhaps much less tidy, but full of verve in its adventurous penetration of new territories. Of course, from the parade-ground behaviour of a force, an experienced commander can infer how it will go into action. But to the uninitiated this is not so easy; and one believes that something analogous will represent the experience of different classes of readers of this book.

The author says that "the main emphasis of the book is on the development of the basic ideas of the theory of relativity". Bearing out the foregoing criticism, one actually finds the emphasis falling unduly upon their formal development. Indeed, one wishes that some of the formalism of the development had been spared for the statement of the ideas themselves. Some of these, such as the reason for the linearity of the Lorentz transformation, the principle of general covariance, and the reasons for taking the world-lines of free particles to be ordinary geodesics and those of light-pulses to be null geodesics, are introduced rather casually and obscurely, and their implications by no means clearly brought out. In fact, the whole treatment of the postulates is neither compelling nor profound. For example, a good deal is made of the fact that general relativity overcomes the difficulty of 'action at a distance' by providing a 'field theory' of gravitation. Surely a more comprehensible, while deeper, view is that we are anyhow looking only for a mathematical description of phenomena, and that general relativity provides a better one than classical theory by simply abolishing the dualism between space-time and matter.

There are two remarkable omissions: the cosmological applications of the theory and the fundamental problem of extracting 'observable relations' from the mathematical formalism. These topics have been largely responsible for the resuscitated interest in relativity in recent years and it is surprising to find them not even mentioned as part of "the development of the basic ideas" of the theory. Actually they have been treated at length elsewhere, for example, in a fairly recent book by Tolman, but that suggests another shortcoming of the present book: it contains references for the work that is described, but none for what is omitted from its limited scope.

There are some misprints, slips, and obscurities in the algebra, but those detected by the reviewer are not vital.

The book will prove a valuable adjunct to the teaching of relativity, but, in the reviewer's opinion, it could scarcely be relied upon by itself to give a student a well-balanced grasp of the subject.

W. H. McCrea.

IMMUNITY AGAINST ANIMAL PARASITES

Immunity against Animal Parasites

By Prof. James T. Culbertson. Pp. x+274. (New York: Columbia University Press; London: Oxford University Press, 1941.) 36*s*. 6*d*. net.

This most readable and interesting book is divided into three parts. The first discusses the general principles underlying natural resistance and acquired immunity to parasitic infections. The factors influencing natural resistance to parasitic infection are numerous and no one of them applies to all examples. The importance of the genetic constitution of the host is clearly shown in the differing racial resistance to malaria; negroes—even the very young before natural infection can confuse the issue—sometimes resist all efforts to infect them with *P. vivax*, whereas white persons are uniformly susceptible. Age also plays its part in resistance, and a complete chapter is devoted to the discussion of the various ways in which age influences immunity to parasites. Sex appears relatively unimportant although resistance to a few diseases is apparently influenced by this factor. Intercurrent infections usually result in depression of resistance but in some instances resistance to one parasite may be increased by simultaneous infection by another, as is demonstrated by the diminished pathogenicity of certain trypanosomes in mice infected with spirochætes compared to the same trypanosomal infection alone, and by the behaviour of different species of malarial parasites simultaneously infecting man. The character of the diet also influences profoundly certain parasitic infections; and although the most conspicuous effects are seen upon parasites residing in the alimentary canal, yet there is evidence of dietary influences on some somatic infections. The various organs and tissues also play their own special part in resistance to parasitic infection; the action of the reticulo-endothelial system is well recognized, but the effect of special defensive factors associated with other cells of the host and the influence of various invasive factors of the parasites themselves are not so commonly taken into account.

Turning to acquired immunity, the reader will find that therapeutic application has not perhaps made the progress that might have been hoped. This may well be because of the inherent complexity of the antigenic factors concerned, while an obvious teleological explanation is that the parasites so largely depend upon a tolerant balance between themselves and host. Nevertheless, a considerable amount of knowledge on the principles and mechanism of acquired immunity to parasites has accumulated since the first clear demonstration of such immunity almost fifty years ago, when Theobald Smith and Kilbourne showed that recovery from one attack of Texas fever protected cattle against subsequent attacks, and many aspects of parasitic immunity have been investigated, some with notable success. Premunition, local immunity and the influence of various mechanisms including skin response, agglutination and precipitin reactions, and the adhesion phenomenon are all discussed.

In the second section the various parasites are discussed separately and the specific immunological reactions associated with infection by them are described in detail. This section concludes with an interesting chapter on responses to arthropods, not only to bites and stings but also to somatic infection with such of them as infect the tissues.

The third part, which although short is not the least valuable, is devoted to applied immunology, and besides dealing with the practical diagnosis of parasitic infection by immunological means and the attempts that have been made to protect against such infection, gives an interesting chapter on the classification of parasites on immunological grounds.

It is clear that the chief developments have been in the field of the diagnostic tests for the various parasitic infections of man and domesticated animals, and in some diseases, particularly the somatic helminthiases, eminent success has been attained. These tests employ chiefly the detection of antibody in the tissues or blood, and so far comparatively little practical use has been made of tests for antigen, a matter for some regret, since such tests would have the advantage of detecting infection in its earlier stages. Somewhat disappointing practical results have attended attempts to produce successful vaccines against parasitic infections and it appears extraordinarily difficult to reduce the virulence of an animal parasite while at the same time preserving its natural antigenic qualities. Nevertheless, as complete information becomes available, it appears more and more probable that no fundamental differences exist in the character of the immune responses to the parasites and to other agencies of disease.

Prof. Culbertson, as he himself states, has taken Taliaferro's classical monograph as his point of departure and he has worthily upheld the high tradition of the American school in this field of study. Not only has he most adequately sifted and summarized modern work, but also his text is most clearly annotated with references to original papers, and the book is therefore a very valuable review which should be in the hands of all interested in the subject.

F. Murgatroyd.

A STUDY OF DELINQUENCY

The Adolescent Criminal

A Medico-Sociological Study of 4,000 Male Adolescents. By Dr. W. Norwood East, in collaboration with Dr. Percy Stocks and H. T. P. Young. Pp. xi+327. (London: J. and A. Churchill, Ltd., 1942.) 45*s*.

THE inquiry carried out by Dr. East and his collaborators on Borstal boys is by far the most important official study of its subject, and appears at an opportune moment when the general public in Great Britain is much exercised over the alleged increase of delinquency among older lads. It carries forward, and in the main confirms, the earlier studies made of young delinquents of school age.

Between 1930 and 1937 nearly twenty-two thousand lads were received into Wormwood Scrubs prison, and examined in regard to fitness for detention in a Borstal institution. Of these, four thousand were made the subject of an intensive investigation. A medical officer carried out a detailed physical examination and applied tests of intelligence; and supplementary data were systematically collected from parents, police, probation officer and school. Unfortunately, as was almost inevitable, no comparable sample, drawn from the ordinary law-abiding population of the same age and the same social class, could be investigated at the same time, so as to obtain a control-group. To some extent the limitation is corrected by the possibility of comparing the conditions among those convicted for different types of crime or those committing crimes with different degrees of frequency. The causal factors observed are classified under the headings that are now usual in such investigations; and the statistical significance of the differences found has been checked throughout by the appropriate chi-squared test.

The discussion of the results obtained begins with a survey of factors popularly supposed to be 'hereditary'. A family history of crime was reported in 5 per cent of the cases: it was somewhat more frequent among those convicted of offences against property and those with more than one conviction. A family history of insanity was found in 3 per cent: such a history was found more frequently among those convicted of sex offences, but was no more frequent among those with more than one conviction than among the remainder. A family history of psycho-neurosis was found in only 2 per cent; and "no significant result emerged from this aspect of the investigation". So far, therefore, hereditary factors would appear to play but a minor part.

Among environmental factors, the home conditions of the delinquent proved, as usual, to be of supreme importance. The average size of the families from which these young offenders were drawn ("5 children alive including the boy himself") was appreciably larger than the average size of comparable families in the population as a whole. There was, too, a significant association between the absence of one or both parents (particularly of the father), or the departure of an older brother or sister from the home, and the commission of multiple offences against persons or property. The presence of quarrelsome relatives, and particularly of quarrelsome parents, appeared to be a not uncommon factor where the offences had been committed against persons or against discipline. Lads under lax, careless, or repressive control, and lads who had lived away from home, showed a greater tendency to repeat offences.

Owing to the limitations of the inquiry, little evidence was available on the connexion between crime and poverty. It was noted, however, that convictions for sex offences were less common among lads coming from the poorer districts. The total percentage of time spent by these lads in unemployment was not apparently any greater than that so spent by the general population of the same sex and age; but at the actual date of committing their offences a large number were temporarily unemployed. Between high earnings and multiple convictions a well-marked association was observed; and Dr. East directs attention to the paradoxical conclusion that seems to follow: "attributes which determine a lad to commit multiple offences (initiative, aggressiveness, selfishness) may sometimes favour his earning capacity".

Turning to the personal characteristics of the lads themselves, we find detailed tables for bodily defects and diseases and for physical conditions generally. But, once again, inferences are difficult to draw owing to our ignorance about the prevalence of such conditions in the general population at this age. On the whole, as Dr. East points out, his data do not confirm Dr. Goring's conclusions, namely, that "thieves and burglars are inferior in stature and weight", and that "those convicted of violence are, if anything, above the average in general physique".

The psychological aspect of the inquiry was limited mainly, though not entirely, to the investigation of definite abnormalities. Nearly 4 per cent of the lads were found to be mentally defective—a proportion far higher than would be found among the general population; and of those who had attended primary schools, scarcely one half had succeeded in reaching the highest class. Dr. East rightly concludes that "the subjects taught in the ordinary elementary school must be made to appeal to this type of scholar, if his activities are to be directed into socially useful channels; and to do this it may be necessary to go outside the ordinary curriculum". On the temperamental side he draws a suggestive distinction between the more active and the more passive type of offenders, and points out that, when it comes to treatment, the latter often requires "little more than kindly guidance", while the more aggressive criminal needs "strict custodial supervision". Adolescent instability was a well-marked feature in many of his cases; but more specific abnormalities were comparatively rare: insanity and epilepsy, less than 1 per cent each, psychoneurosis only 1·4 per cent. What are so often regarded as mental abnormalities calling for medical investigation turn out to be merely exaggerated forms of the normal emotional changes that accompany puberty. "The importance of the biological aspect is shown by the fact that during adolescence certain inborn instincts, namely, those of sex, aggression, gregariousness, acquisitiveness and self-assertiveness, become more direct and importunate"; and, as the detailed classifications show, these characteristics "seem often to determine the direction which the criminal outburst takes". The notion, still popular with medical writers, that crime is a "form of illness" Dr. East most strongly repudiates; and here every psychologist will agree with him.

Of the practical conclusions deduced from this valuable inquiry, the most important is the need for further scientific study. In particular, a "centre for criminological research" is advocated, "from which special forms of research at other penal establishments should be directed".

CYRIL BURT.

THE PHYSICAL BASIS OF LIFE

Cytology and Cell Physiology

Edited by Geoffrey Bourne. Pp. xii+296+21 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1942.) 20*s*. net.

IT would be an interesting experience to obtain access to a contemporary review by an impartial music critic of the celebrated incident of "fiddling while Rome burned"; it might provide a helpful guide to the correct mode of approach to a volume composed, so the preface informs us, entirely during the 1940–41 air *Blitzkrieg* on Britain. The preface goes on to relate how bombs were probably audible during part of every chapter, that one essay was written in an air-raid shelter, another in railway trains, etc., until a reader may feel tempted to ask why, in these circumstances, were such difficulties not regarded as grounds for deferring publication? An answer to this can be given, but only after the book has been read, and it seems a pity that the producers themselves should have presented a work of scholarship to the scientific world in terms which suggest a peculiar form of A.R.P. Adverse circumstances can indeed provide an explanation for shortcomings, if such is required; but it is difficult to see that they can add anything otherwise to the scientific value of the result.

The book is actually a collection of essays by nine collaborators on a variety of topics almost all of which could be included under a heading such as aspects of cell structure and physiology in animals. Each essay has an introduction and most end with a conclusion. They could be read with equal profit in any order. The matter ranges from an eye-witness account of fertilization in a sea-urchin (p. 93) to the biochemical details of digestion in the grub of the clothes moth (p. 206); from the pure physics of protein monolayers (p. 58 *et seq.*) to the distribution of mineral components in the walls of the blood vessels of human patients suffering from arteriosclerosis (p. 179–82). A reader at the end of it all may be tempted to quote with respect to the book as a whole a sentence intended by its author to apply only to the last chapter (on pathological cytology), namely, that "the problems encountered in this survey have been many and varied, the gaps in our knowledge extensive, so that at the present time a synthetic discussion seems unprofitable", and to ask whether that was really the principal conclusion that the authors intended to convey?

In considering this question it is necessary to bear in mind not only the inevitable difficulties of composite authorship, but also the peculiar nature of the subject. It must be assumed that the larger problem to which this volume is intended to contribute is that of providing a physico-chemical description of cell structure and function. Such a description must ultimately entail the successful exploration of a region of space which is at present more inaccessible to observation than almost any other. The world of the microscope ceases to be visible at sizes below about a third of a micron; but the world made familiar by the ordinary tools of atomic physics and chemistry is not reached at once but only when the scale of significant distances has shrunk to the order of a few angstroms. The gulf between these two worlds may be gauged by the comparison that $1 \mu = 10{,}000$ A., and in this almost uncharted region lies the structural framework behind almost all cytological problems, including fundamental issues such as the physical basis of life. A reader (or writer) who underestimates the immense and inherent difficulties of the ultimate problem will court disappointment deservedly.

The part that composite authorship has played in the presentation of the subject in the present instance may perhaps best be made clear by more detailed enumeration of the topics dealt with. The more significant of these may be selectively listed as: some chemical principles of cytological technique; experimental methods of studying unimolecular films; the plasma membrane; mitochondria and Golgi apparatus; some points of chromosome structure; microincineration; pathological cytology (including cancer). Clearly the synthetic discussion of all this material could only have been effected, were it possible at all, by one mind writing, and its absence here must be accepted as inevitable. The general impression conveyed by the book as a whole cannot therefore have been the principal object of writing it.

Composite authorship, on the other hand, has the merit, perhaps its only one, of making possible a more detailed and authoritative presentation of a greater variety of aspects of the main theme than can normally be supplied by one person. This is the case here. No single reader is likely to be equally versed in all the topics dealt with and something new and useful can scarcely fail to be learned by anyone interested enough to read the book carefully. Some things could, however, have been improved even within the selected framework. Thus the general inadequacy of representation of the botanical point of view is very obvious to a botanical reader, and is to be regretted in that, for some at least of the topics dealt with, botanical literature preponderates. This is conspicuously true for subjects such as protoplasmic permeability and spiral structure of chromosomes. In other places a timely reference to a plant, such as to the Fucus egg in connexion with artificial parthenogenesis, might have modified a general statement, while recognition of the relevance of some fields of plant pathology to an intractable cytological problem such as that of cancer would have enriched the book.

Another characteristic which may be expected to deter a reader from casual perusal is perhaps merely the reverse side of the book's most obvious virtue. In the attempt to overcome the undoubted difficulties of compilation, much of the matter tends to have been compressed together in a form closely resembling a catalogue. This may have its justification if completeness is thereby attained, but much is lost both in coherence and in power to stimulate thought. To quote one example, the work on the tobacco mosaic virus, mentioned among other matters on p. 243, is commonly regarded as one of the most important recent developments in the whole of biology; but this type of emphasis must be supplied, if at all, by the reader. The reader, in the same way, will have to extract, with some labour, from the close-packed pages of physics and biochemistry, the few really cytological facts which they contain, or, conversely, he may list on a piece of paper those few facts of sufficiently authenticated physics and chemistry to be found in the cytological chapters. The material is there, but the labour must be his.

In spite of these drawbacks the book does succeed to a considerable extent in achieving what must be regarded as its real and immediate object. This is something far humbler than the synthetic review of any one main theme, and may be thought of as the presentation of a record or series of records of the state to which the selected topics had arrived up to and to a limited extent beyond the outbreak of war. In this it is successful in exact proportion to the degree in which the personal interests and work of each writer is or is not closely linked with his topic. Where sidelines have been introduced for the sake of an imaginary completeness the treatment may be so fragmentary that it were better omitted. A case in point is the discussion of the uses of polarized light on pp. 29, 30. Without any mention of important modern monographs, such as those of Schmidt (1937) and Frey-Wyssling (1935, 1938), or of the greatest work of an older generation, that of Naegeli (by which the micellar theory and the existence of crystalline properties in organic materials was first deduced), such a summary is almost worse than useless. On the other hand, the same writer on a later page has produced a highly interesting account of the nature of the cell surface as he sees it, which is valuable to the reader chiefly because the point of view (though not of course all the facts) is the writer's own and based on personal experience.

The fact that quite a large part of this book could be described in the latter terms is the best tribute which can be paid to it and one which sufficiently explains its publication in spite of difficulties. Deferment would not have improved it since the effects of cessation of international intercourse will be felt more and more as long as the War lasts and the difficulties of collating literature will not grow less. As a serious contribution to cytological literature this book deserves a place in every scientific library.

One word of kindly advice may, however, be offered to the cytological civilian who may have to face a new *Blitzkrieg* in 1942–43. Let him take this book with him into his dugout by all means, but let him also take two other volumes, namely, Gray's "Textbook of Experimental Cytology" (1931) and the Cold Spring Harbor Symposium on Nuclear Biology (1941). These will provide relaxation from the more solemn tasks of A.R.P. and remind him of the happier days when Rome was not on fire.

I. Manton.

NEW LIGHT ON THE APOCALYPSE OF ST. JOHN

The Book of Revelation is History

By H. S. Bellamy. Pp. 204. (London: Faber and Faber, Ltd., 1942.) 8*s*. 6*d*. net.

Mr. BELLAMY'S interpretation of the Apocalypse is entirely cosmological, being based upon the theory of the Austrian, Hoerbiger, concerning the attraction and ultimate destruction of satellites. Mr. Bellamy discovers in the Book of Revelation three cycles of myths, all concerned with a most appalling cataclysm which occurred thousands of centuries ago —the attraction and disintegration by the earth's gravitation of the satellite which was the predecessor of our present moon. He discovers further mythological material which he traces to a subsequent cataclysm which occurred when the planet Luna was captured by the earth's gravitation about fifteen thousand years ago, causing the sudden submergence of the continent of Atlantis.

The editor of the Apocalypse, says Mr. Bellamy, must have derived his knowledge from some esoteric source, either on the isle of Patmos where he went "for the word of God", or from some other source which the name is used to conceal. The first myth (Rev. i, 1–20) is a general survey of the scene before the disintegration began. The satellite would at this time appear to be very near the earth and brilliantly lighted. Thus a group of brilliantly lit craterlets might well seem to be a group of stars, and the face of the satellite would almost certainly be covered with grotesque shapes. The second myth (iv, 1–8) is a series of observations of these, in which the imaginative eye sees them as the four-and-twenty seats, the elders, and the beasts "who rest not day or night". The "sea of glass like unto crystal" indicates the glaciosphere of the satellite. When the disruptive pull of terrestrial gravitation began to outweigh the internal cohesion of the satellite, this glaciosphere would crack and split into slabs. These slabs would crowd towards the apex so that new forms, for example a 'lamb', a 'book', a 'throne', might appear. The actual beginning of the disintegration is seen as the 'opening of the seals'; then follows the account of the disintegration proper under the symbol of the sending forth of the four horses. The white horse signifies the white, or icy, stage, the red horse the ensuing stage in which the glaciosphere is entirely stripped away revealing the red soil beneath, the black horse the bare metallic core of the satellite, which under disintegration would shine livid in the light—the pale horse. The rain of blood is the fall of the red soil, and the star which fell from heaven opening the bottomless pit (ix, 1,2) a huge meteorite which pierced the terrestrial crust of the earth and penetrated to the magmatic strata beneath. Mr. Bellamy traces other references to this breakdown cataclysm in appendixes on Ezekiel, Ezra, Enoch, and others.

Mr. Bellamy identifies "mystery Babylon" with Atlantis. "The great πολις was found no more, because this angel had thrown into the sea a huge white round object, like unto a mill-stone" (Rev. xviii, 21). Again quoting from the book of Ezekiel, "How art thou destroyed that wast inhabited by seafaring men, the renowned city that was strong in the sea. . . . Now shall the isles tremble in the day of thy fall; yea the isles that are in the sea shall be troubled at thy departure" (xxvi, 17–18). Space does not allow more than a reference to these survivals of Atlantis myths which the author traces.

Supposing this explanation to be scientifically probable, why should the editor of the Apocalypse have attached such religious importance to so purely cosmological a chronicle? The author makes the interesting observation that he lived at a time of great crisis when established codes of behaviour were losing hold of the masses, as at the present day. His work may therefore have been an attempt to show the relationship between religion and science, so as to disentangle religion from crumbling conventionalism. He may have been trying to use the history of these cataclysms to reveal the hidden relationship between the inner lives of individuals and the lives of nations and of the world, so as to dissolve the dividing wall which current ethics would set between the scientific and religious points of view. Such a book, then, while justly claiming absolute truth, would admit of different interpretations according to the religious development of the reader; for the fact that heaven and hell may be cosmologically interpreted does not preclude other interpretations on different levels of consciousness. The dead are still burying their own dead, and the living are still being led unscathed through the ten circles of hell.

B. M. B.

RELATION OF MINERAL RESOURCES TO WORLD PEACE*

By Sir THOMAS HOLLAND, K.C.S.I., K.C.I.E., F.R.S.

AMONG the raw materials referred to in the Atlantic Charter minerals are, beyond question, the most important because of their natural occurrence under fixed geographical conditions which cannot be changed by any artificial measures. They are essential to all technical industries; and, rightly or wrongly, applied technology has become an inevitable and ineradicable phase of our civilization. No civilized community can now exist without a sufficient, and sufficiently varied, supply of mineral products; substitutes for them cannot be provided, except to a very small degree, by other materials, natural or artificial, without increased cost and loss of efficiency. The demand for them is insistent and certainly will increase in the immediate future. The problems before us are therefore urgent.

Yet the workable deposits of useful minerals are distributed without regard to climate or established national boundaries. It follows, consequently, that, so long as difficulties are created among the nations for the exchange of such raw materials, there must always be potential friction between the 'haves' and the 'have nots'. One can even go further without intelligent contradiction and say that, whereas tariffs can hamper international trade in mineral products, no tariff can prevent the trade altogether without the immediate creation of conditions which are certain to lead to war.

It will not be possible here to do more than present one or two illustrations to show the importance of selecting this section of the Atlantic Charter for special discussion; and this limitation to mineral questions does not mean that we fail to recognize the similar significance of other raw materials.

But it is the speed of change in the international bearing of mineral questions which gives them special urgency. During the first thirty-seven years of this century, the output of ordinary steel in the United States increased five times, from about 10 to more than 50 million tons, and, to produce the output for 1937, three fourths of a million tons of manganese ore had to be imported as one constituent among the necessary raw materials. In the latter year, with the help of a protective tariff amounting to about 100 per cent of the import price of manganese ore, the United States did not produce enough of the ore from domestic sources to meet much more than about five per cent of that country's own essential requirements. (In giving these round figures I am not unmindful of the fact that research on methods for concentrating the large deposits of American low-grade ores shows some signs of possible success in times of high prices or during the emergency of war.) You can guess therefore what the result would be if an extension of the recent tendency towards nationalism went so far as to prohibit the export of manganese ore to the United States from the four or five principal sources—the British Empire which then produced one third of the world's total of six million tons, and Russia which produced another third, both countries, especially Russia, wanting a large share of their own outputs; while France, Germany and Japan, producing between them negligible amounts, wanted most of the remaining third.

Short of absolute prohibition, tariffs might conceivably force the United States to exploit more vigorously its own resources at home and in Cuba, with the result, however, that all known workable high-grade resources at the disposal of the American Government would be effectively exhausted within a few years. The world is so made that the chief steel-making countries—the United States, Great Britain, Germany, France, Italy and Japan—have little more than negligible resources of manganese ore to rely on within their own political boundaries, whereas the countries in which the mineral occurs in greatest abundance are but small consumers of it. During 1937, four fifths of the world's output of steel occurred in countries which produced only about two per cent of the required manganese[†].

India is now producing about a million tons of steel annually, but uses for the purpose less than two per cent of its own output of manganese ore. Russia thus becomes an outstanding exception; for many years it has been the world's chief producer of manganese, and, unexpectedly to others, during the decade before 1937 increased its output of steel ten times, thus passing from the sixth to the third position among the steel-making countries.

Now we can speculate with some degree of certainty on one important reason why Germany suddenly broke her pact and invaded Russia. It is a prospective shortage of manganese rather than of petroleum which threatens disaster to Germany's munition supplies. Petroleum can be made to some degree and to an increasing extent from the abundant brown coal supplies in Germany itself, although this incurs the absorption of much technical man-power, and nearly sufficient natural supplies are obtainable from other controlled countries, especially Rumania. But of manganese, all the European countries under the domination of Germany cannot together produce more than a fraction of that necessary to feed the steel furnaces under German control. Before the War the countries now under German domination imported annually more than 1½ million tons of high-grade manganese ore. The most productive among them has never turned out a tenth of this quantity, and even that is of a relatively low grade. Before the War of 1914–18, both France and Germany had accumulated some stocks of manganese, but not nearly enough to see them through, and Germany, being hampered at sea, was finally in serious difficulty.

One cannot, however, be confident in estimating the stocks of manganese still available in countries now under German control, because, while there is evidence that Germany herself was very late in commencing to accumulate stocks of imported ore for emergency use, it is obvious that France began soon after 1922 and continued annually to import far more manganese than was necessary for her output of steel[‡]. This is but one of the many ways in which the French people and their Allies have been 'let down' by a few of their weak and treacherous political leaders.

Whatever doubt on this account there may be about Germany's access to reserves of manganese, one can be more certain about her anxiety to exploit some others of the varied mineral resources of the Soviet, and one of these is almost certainly the

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[*] Substance of the opening address at the Conference on "Mineral Resources and the Atlantic Charter" of the Division for the Social and International Relations of Science of the British Association on July 24–25.

[†] Roush, G. A., "Strategic Mineral Supplies" (McGraw-Hill, 1939), p. 38.

[‡] Roush, G. A., *op. cit.*, p. 68.

relatively rare metal platinum, which is wanted in fairly large quantities for various war industries as well as for the manufacture of nitrous explosives. Although the output of the precious metal has trebled during the past twenty years, the substantial sources of supply are still under the control of the united democratic nations, Canada producing about a half, Russia about one fifth, America and South Africa between them another fifth, supplemented by smaller quantities from the Republic of Colombia, Belgian Congo and Abyssinia.

The argument which I have used, based on our information about the natural distribution of manganese ore in the world, is no lonely illustration of the fact that the occurrence of mineral raw materials does not coincide even approximately with the national domains in which industries have been most highly developed. There are others of a similar type on which the continuance of present civilized activities are dependent, and the American Government, wisely listening to its scientific and technical advisers, has labelled a dozen such minerals, on this account, as strategic, that is, minerals on which the United States depend on outside—sometimes distant—sources, for those supplies which are absolutely necessary to maintain essential industries and therefore to ensure safety in defence.

Manganese came into general use soon after the invention of the Bessemer process in the middle of the last century, and well over 90 per cent of the metal produced in the world is now consumed in steel-smelting. Although the metal is thus consumed only in a way analogous to that of a medicine, there is no known substitute to take its place on a large scale, and so under present war conditions it becomes a 'key' product.

But out of the study of its function in this way, there arose some twenty-five years later a quite different use for the metal as a definite constituent of the manganese-steel which was invented by the late Sir Robert Hadfield. His invention of manganese-steel opened up a new era in metallurgy, for it became the forerunner of a whole family of alloys of iron with relatively rare elements like cobalt, chromium, molybdenum, nickel and tungsten.

It was the discovery and extended use of these new alloys which changed, and changed on a large scale, the problem of supplies for the industrialized Great Powers. In the last century mechanical industries sprang up around areas containing deposits of the small number of natural products required in the manufacture of ordinary iron and steel; for example, around the British coalfields, in which there occurred associated supplies of iron ore, limestone flux and coking coal. When the local supplies of ore became exhausted, improved transport facilities enabled Great Britain to bring iron ore from Spain and Scandinavia. But then again when ferro-alloys, with their very special and previously unexpected properties, superseded ordinary steel, their constituents had to be brought from still more distant parts of the earth, and the whole problem of commercial success in industry, as well as security in war, thus assumed an entirely new configuration. For, in addition to the family of ferro-alloys, other metallic alloys of industrial importance were discovered, such as those largely made of aluminium and magnesium, combining low density with sufficient strength for aircraft construction. Nor indeed is the end of this avenue of metallurgical development in sight or even predictable.

A country like Great Britain, which was practically self-contained for the few and simple essential constituents of ordinary steel up to the last quarter of the nineteenth century, quickly found itself dependent on supplies from distant parts of the Empire, and even from foreign competitors. From the happy condition of congratulating itself, the new century found Great Britain, for example, looking to Canada and the Belgian Congo for cobalt, to British Guiana and France for aluminium ore, to Canada for nickel, to India and the Gold Coast for manganese, to China and Burma for tungsten. A new meaning was given to the importance of retaining command of the seas, which seems now to be giving place to command of the air.

These are but a few among many mineral products which are just as essential as imported food for our continued existence as a nation; and indeed more so, because no artificial effort can grow minerals where they have not been placed already by Nature. There are not and never will be available synthetic metals for industrial use. We can use plastic products for door knobs and ash trays to economize in imported copper and zinc for brass, but we cannot economically replace bauxite, which we must import for its aluminium, by aluminous clay which we have in abundance; and generally, while one metal can occasionally be used to replace another at greater cost and reduced efficiency, so far as Great Britain is concerned, we cannot produce even an inefficient substitute. But Great Britain is not unique in this respect. France, Germany, Italy and Japan, as independent units, are also dependent on the outside world in other ways and to different degrees. Even the United States can never be self-contained. Nor can any country derive comfort and security from its greater approach to self-sufficiency; for what is the use of being able to build a motor-car if we are dependent on another country for a sparking-plug?

So far I have spoken of essential minerals in qualitative terms. When we consider the situation quantitatively, the problem takes a much more serious aspect. The extension of our demands in kind is being accompanied by a correspondingly increased consumption in quantity, with one immediate and dangerous result that smaller deposits of useful minerals must be neglected for richer and larger masses which can be exploited in bulk. The pace in consumption has increased since 1900 on a scale which has resulted in a greater output than the total production of all previous history back to the Stone Age.

This comprehensive statement has been met, I know, with the criticism that statistical records do not extend back beyond the nineteenth century; but its accuracy can be checked by a simple diagram for any representative mineral used in the industrial arts and therefore can be applied to the whole. We might, for example, take a metal like copper as one which is familiar to everyone by its widespread use in a variety of ways. At the beginning of the nineteenth century the world produced about 10,000 tons of copper a year, by the middle of the century about 40,000 tons, and before the century finished, production had reached half a million tons annually. The curve of production went on rising, with only two serious setbacks, until it indicated in 1937 that the annual output had passed two million tons. It is easy to see that the area of the curve enclosed between 1900 and 1927 must necessarily exceed that of all previous periods since man became a metallurgist. Similar curves, not always rising so steeply, tell the same story for other familiar metals.

This matter is not mentioned as a mere curiosity of industrial history: it is to show that, with the growth of national exclusiveness in recent years, there has sprung up an increased interdependence among the nations and especially among the greater Powers, beyond the control and, one can say with safety, beyond the mental comprehension of those politicians who have had most to say, and too much influence, on the international questions which have brought us to the present condition of universal war.

As one result of vague fears of aggressive trespass during the past twenty years, and in spite of isolated attempts to the contrary, the nations have become more and more self-conscious, and, with regard to their natural possessions of minerals, more inclined to conserve their resources. Many of them, the British Empire no less than others, have refused the grant of concessions to prospect for or to exploit mineral deposits, thinking through vague fear that some vital asset may thus be squandered; forgetting, however, that a mineral deposit cannot in an emergency be readily turned to account by the nation itself unless it is already developed, overlooking the fact that, even under war conditions, a mine cannot be taken out of the country in which it lies, and failing to realize that what matters is not the nationality of the mining company which risks its money in prospecting and mining, but in which country the mineral is finally prepared for use in the arts—the arts of peace or the arts of war.

Failure generally to appreciate the fact that civilization cannot go on at all without the international exchange of minerals has developed at times a general atmosphere of tension that cannot be relieved except by war. As no country can ever be self-contained in future for essential mineral raw materials, no nation can contribute its share to the progress of civilization without the operation of principles such as those outlined in the Atlantic Charter. But for democratic nations to implement those principles, it is necessary for the public to understand far more than they do now the part which mineral problems play in civilized activities.

In the United States the problems have been examined in critical detail for several years by selected committees of technological specialists, but naturally their chief object has been to provide military security for the nation in a world threatened by potential aggressors.

The Soviet Republics of Russia have done the same by official organizations, and most of the world seems so far to have failed to appreciate the extent of their resources or the realistic thoroughness which has actuated the present Government of the U.S.S.R. in the utilization of applied science.

Fifteen years ago, the British Empire Council of Mining and Metallurgical Engineers formulated proposals for a similar investigation of our scattered resources, but the Dominion Governments have apparently been dominated by the immediate problems of promoting inter-Empire commerce, and have consequently overlooked the dangers of national exclusiveness regarding mineral raw materials, which all well-behaved nations must reasonably obtain if civilization, such as we know it, is to survive.

At the time of the South African meeting of the British Association, I could see no further than a possible understanding—which is the first necessary step towards agreement—between the United States and the British Commonwealth, which between them, at the time, controlled three fourths of the world's workable deposits. My imagination takes me in the same direction still, but very little further along the road towards the development of an international conscience about the hoarding of mineral deposits.

Another serious effort should be made to formulate measures for facilitating the international flow of mineral products, keeping always in mind the simple circumstances that no country is or will be self-contained for mineral supplies, and no development of science can or ever will grow workable mineral deposits where they are not already formed by Nature. And I ought perhaps to repeat what I suggested at the beginning, that this question is by no means a matter of academic interest. It is one that must be settled and settled quickly by practical measures if civilization is to be saved for our descendants. Unless it is settled, and settled quickly at the end of the War, by an intelligent understanding among the successful Powers, newly concocted aggressive attempts to enforce control will lead intermittently to further outbreaks of war. Delay for more mature consideration may be the rashest step to take.

REFLEXION OF X-RAYS WITH CHANGE OF FREQUENCY

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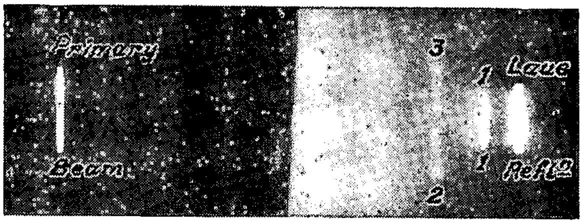
In *Current Science* of April, 1940, photographs were published exhibiting the very remarkable phenomena observed when a pencil of X-radiation from a copper target traverses a cleavage plate of diamond and the resulting Laue diagrams are recorded with adequate exposures. The photographs showed monochromatic X-ray reflexions from the (111) planes of the crystal which were quite sharply defined at all settings of the crystal but which were evidently different from the well-known Bragg reflexions. As this phenomenon was inexplicable on the existing X-ray theories, it was interpreted as follows: X-ray photons traversing a crystal can exchange energy with it, giving up or taking on a quantum of energy corresponding to the frequency of one or another of the infra-red or high-frequency vibrations of the crystal lattice; the X-rays are then geometrically reflected by the lattice planes of the crystal with a change of frequency. Further study of the effects exhibited by the (111) planes of diamond showed them to be in complete accord with the ideas outlined in the article of April, 1940 (see accompanying



Triple quantum reflexions by the (111) planes in diamond.

illustration). If the fundamental process stated is possible with diamond, it should also occur and be observable with other crystals. Investigations were made which showed that this is actually the case; these are described in a whole series of papers published in the *Proceedings of the Indian Academy of Sciences* and in *Current Science* from May, 1940, onwards.

The purpose of this article is to present a general account of these investigations, and in particular to show how the reality of the frequency changes in X-ray reflexion has been demonstrated and their magnitude determined from intensity measurements at various temperatures.

Earlier X-Ray Theories

The fundamental X-ray process stated above presents a formal analogy with the scattering of light in crystals with change of frequency discovered by me in 1928, except that we have a geometric reflexion of the X-rays instead of the diffuse scattering observed with ordinary light. Why the possibility of such a process is not indicated by the existing X-ray theories is a point of some interest. In this connexion, a memoir by Laue (1926) in which he discussed the effect of the thermal agitation on X-ray propagation in crystals is well worthy of study. Laue showed that assumptions of the most divergent character regarding the nature of the thermal agitation in crystals lead to closely analogous expressions for the temperature factor in the intensity of the ordinary X-ray reflexions. Hence, even a reasonably good fit of the temperature factor with the experimental facts in selected cases cannot be regarded as evidence that the theoretical assumptions from which it is derived correspond with reality. The position is, in fact, closely analogous to that arising in the theory of specific heats, where very different formulæ (Nernst-Lindemann, Debye, Born-Karman) all fit the facts in certain simple cases fairly well.

A completely different situation arises when we consider the secondary radiations from the atoms which do not appear in the direction of the usual geometric reflexions. Here, as Laue remarked, the changes of frequency arising from the oscillations of the atoms are of fundamental importance, since only radiations of absolutely identical frequency can reinforce or cancel each other by interference. Hence, the spectroscopic properties of the crystal are of the very essence of the problem. If, therefore, we start off with assumptions regarding these properties which do not correspond with reality, the deductions therefrom will equally fail to represent the truth. This, actually, is the situation of the Faxén–Waller theory of X-ray diffraction in crystals, which rests on Born's postulate of the cyclic lattice. Born's crystal dynamics is based on the same idea as the specific heat theory of Debye, namely, that the distinct frequencies of atomic vibration in a crystal are as numerous as the atoms themselves and accordingly form a continuous spectrum. This assumption is contrary to the experimental facts of spectroscopy. Several distinct methods of spectroscopic research agree in indicating that a sharply defined monochromatism of the frequencies of atomic vibration in the near and remote infra-red is characteristic of the crystalline state; for the same reason and to the same extent that a perfect three-dimensional periodicity of the static arrangement of the atoms in space is characteristic of crystals.

Dynamic Reflexion of X-Rays

If, following Debye and Born, we assume that the frequencies of atomic vibration are as numerous as the atoms themselves, it follows immediately that the secondary radiations arising from such vibrations have correspondingly numerous frequencies and are therefore incapable of reinforcing each other by interference. The effect of partitioning the mechanical energy of vibration into a very large number of distinct frequencies is also to reduce the energy of any particular vibration to vanishingly small proportions. Further, the vibrations of higher frequency would have relatively the smaller amplitudes. Hence on the assumption stated, no distinctive effects could be expected from the high-frequency vibrations, in spite of the fact that practically all the available degrees of freedom of atomic movement are necessarily associated with such high frequencies.

That the Debye-Born concepts of crystal behaviour are unreal is, however, evident from the spectroscopic data. For example, Bhagavantam (1930) found that the spectrum of monochromatic light scattered in diamond exhibits an extremely intense and perfectly sharp line with a frequency shift of 1,332 wave numbers, besides several other feeble lines with both larger and smaller frequency shifts. Nayar (1942) studied the blue fluorescence spectrum of diamond and the corresponding absorption spectrum in the near ultra-violet. On immersing the diamond in liquid air, these spectra appear resolved into discrete lines. The frequency shifts of these lines from the electronic band at 4152 A. common to both absorption and fluorescence were found to be positive for one and negative for the other, but otherwise absolutely identical. Nayar was thus able to discover and measure nineteen discrete frequencies in the lattice spectrum of diamond, ranging from 1,384 to 176 wave-numbers per centimetre. Considering the simplicity of the crystal structure of diamond, these facts can only be regarded as a direct experimental refutation of the Born dynamics.

We are therefore justified in rejecting the existing X-ray theories and striking out on a new path which has as its starting-point the observed monochromatism of the infra-red vibrations in a crystal. Each of the observed discrete frequencies of vibration is necessarily associated with a very great number of degrees of freedom; in other words, it represents a mode of vibration occurring similarly and simultaneously in great numbers of the lattice cells, if not in the entire crystal. Such a vibration would give secondary radiations of altered frequency having their origin in the cells of the lattice and having coherent phase-relationships: these would therefore be capable of reinforcing each other and giving a notable intensity in the direction where they agree in phase and a negligible intensity in other directions, in a manner closely analogous to that in which the ordinary Bragg reflexions of unmodified frequency arise. Complete identity of phase of the vibration in all the lattice cells would make the dynamic reflexions observable only in the same crystal settings as the Bragg reflexions. The spectroscopic facts, however, do not appear to demand such a rigorous identity of phase of the vibrations in all parts of the crystal. It may therefore be assumed that a certain variability of the phase is permissible; this idea is given concrete expression in the concept of phase-waves or planes of constant phase for the infra-red vibrations. The possible orientations of these phase-waves would depend on a number of considerations, including especially the structure and symmetry of the crystal and the particular mode of vibration under consideration; such considerations, therefore, also determine the geometric law of the dynamic reflexion.

In view of the change of frequency, we must necessarily regard dynamic X-ray reflexion as involving exchanges of energy between the X-ray photon and the crystal, analogous to those observed in the scattering of light. It follows that the temperature dependence of the intensity of dynamic X-ray reflexion should be of the same general nature as that indicated by the principles of the quantum theory for the scattering of light in crystals with altered frequency. The important difference is that, in the X-ray case, we can only observe the summation of the effects appearing with enhanced and diminished frequencies. Taking note of this, it follows that the reflexions associated with vibrations of high frequency should show a relatively small temperature variation and reach their limiting intensity at moderate temperatures; on the other hand, reflexions associated with vibrations of low frequency should show a more marked temperature dependence and reach their limiting intensity at a very low temperature.

Observations with Diamond

The verdict of the spectroscope which compels us to reject the Debye-Born concepts of crystal behaviour is independently confirmed by the X-ray phenomena. In particular, the effects exhibited by diamond are of such a striking character that they are in themselves a complete refutation of the Born crystal dynamics and *per contra* confirm the essential correctness of the new ideas outlined above. The octahedral planes in diamond are equally inclined to the three cube faces of the crystal. If, therefore, the phase-waves for an oscillation of the alternate layers of atoms in the octahedral planes against each other along the common normal are parallel to one of the cube faces of the crystal, symmetry demands that phase-waves parallel to the other two cube faces should also exist and give dynamic reflexions by the same planes. Further, it is known that such an oscillation has a high infra-red frequency, namely, 1,332 wave-numbers, and that a line with this frequency shift appears in light-scattering with an intensity sensibly independent of the temperature. The X-ray observations show, in agreement with the new idea, that the (111) planes give, in general, three geometrically sharp reflexions which appear in positions which are in perfect accord with the phase-wave formula (see accompanying illustration) over the entire range of crystal settings in orientation and azimuth. Their dynamic character is shown by the fact that the angular separations of the reflexions from the primary beam are not invariable but alter with the setting of the crystal. Further, the intensity of these reflexions scarcely alters with temperature over a wide range from that of liquid air upwards. The intensity of the reflexions diminishes rapidly with diminishing phase-wave length, but neither their perfect sharpness nor their temperature invariance is influenced by an alteration of crystal setting.

The facts stated above are obviously impossible to reconcile with the belief that they arise from vibrations of the elastic solid type having a thermal origin. The supporters of the thermal-elastic theory of X-ray diffraction appreciate this difficulty and have therefore adopted the expedient of trying to remove it by various *ad hoc* hypotheses, for example, that "a strain which is cubic in symmetry is inherent in the majority of diamonds", or that "diamond is not a normal crystal". It is sufficient to remark that suggestions of this kind do not explain the observed facts and that they are physically meaningless. In an article on the physics of the diamond just published (*Current Science*, July, 1942), I have shown that these and other beliefs which have been expressed in recent physical literature about the diamond are without any foundation in fact. Limitations of space prevent a consideration here of further problems which arise, namely, the other modes and frequencies of vibration of the diamond lattice, the X-ray effects exhibited by other lattice planes and the influence on the X-ray phenomena of imperfections of crystal structure when such are actually present in diamond. A discussion of these questions would greatly lengthen this article without really helping to clarify fundamental issues.

Measurement of the Frequency Changes

Whether, in specially favourable cases, X-ray spectroscopy may succeed in directly exhibiting the frequency-changes which arise in the dynamic reflexion of X-rays is a matter for future research. Fortunately, however, the reality of these frequency changes may be demonstrated and their magnitude determined by a very simple method which is of universal application. The method depends on the fact that, according to the principles of the quantum theory, the temperature variation of the intensity of these reflexions depends on the frequency of the lattice vibrations responsible for their production. According to the present theory, this frequency would be independent of the setting of the lattice planes giving the reflexions. On the other hand, in the Faxén-Waller theory of "diffuse thermal scattering of X-rays", the reciprocal of the elastic wave-length and therefore also the frequency of the vibrations giving the "diffuse maxima of scattering" which appear in that theory vary with the setting of the crystal and may be given any desired small value by making the crystal approach the Bragg position sufficiently closely. By holding the crystal in such a position and lowering its temperature to that of liquid air, the "diffuse maximum of scattering" should then diminish in intensity nearly in proportion to the absolute temperature. Tests of this kind have been made at this Institute with diamond by Dr. Nilakantan (1940) and with numerous other crystals (carborundum, rock-salt, sodium nitrate and penta-erythritol) by Dr. Venkateswaran (1941). The experimental results are decisive against the Faxén-Waller theory and show in an unmistakable way that the high-frequency or infra-red vibrations of the crystal lattice and not the low-frequency or elastic vibrations are responsible for the observed dynamic reflexions.

X-Rays and the Infra-Red Spectrum

It is not to be expected that weak and imperfect crystals, for example, soft metals, organic crystals and the like, would give at ordinary temperatures dynamic reflexions which are as geometrically sharp as those observed with diamond. Nevertheless, the published observations with such crystals show that the half-widths of the "diffuse spots" are in many cases, for example, hexamethylene tetramine and urea nitrate, only a small fraction of the separation of the spots from the Laue reflexions and alter but little with the setting of the crystal. These facts clearly indicate that the reflexions observed do not owe their origin to vibrations of the elastic type.

Apart from the points dealt with in the foregoing account of the subject, there is much experimental evidence of a different nature on record which supports the validity of the new approach to X-ray theory made by the present writer. To appreciate fully this evidence, one must be familiar with both the X-ray and the spectroscopic literature. The remarkable way in which the X-ray results illuminate and are illuminated by the facts of spectroscopy will then be evident. In particular may be mentioned the correlations which exist between the geometric characters of the modes of infra-red vibration, especially those of low frequency, established by spectroscopic studies on light-scattering, and the observed intensities of the dynamic X-ray reflexions by the various lattice planes in the crystal. Such correlations are particularly striking when the molecules or ions in the crystal have planar configurations, and their translational and rotational oscillations have low frequencies (as is generally the case); the crystal planes nearly parallel to the ions or molecules then give intense dynamic X-ray reflexions.

NEWS and VIEWS

Scientific Exhibition in Moscow

An exhibition devoted to the cultural relations between the University of Moscow and the universities and scientific institutions of Great Britain and the United States is now open in one of the halls of the University, where the bomb damage suffered in an enemy raid last year has now been made good. The exhibits include many editions of the scientific works of Faraday, Clerk Maxwell, Scott and others, and correspondence between British and American men of science and members of the Russian Natural History Society. Of special interest is a section reflecting the scientific relations between Russian and British scientific workers. There is the unpublished correspondence between Lord Kelvin and Prof. Umov, who was an honorary member of Cambridge University. There is also a selection of letters exchanged between British and American botanists and zoologists. One of the exhibits is a photograph of the famous Russian naturalist Timiryazov wearing the robes of a doctor of the University of Cambridge.

A section devoted to Charles Darwin contains his correspondence with Russian men of science, and a copy of a book written in support of his theories by the Russian zoologist Mensbir, who was one of the first to defend them. Copies of Russian translations of Darwin's works are shown, together with material from the many celebrations in honour of the great British naturalist which have been held in the U.S.S.R. from time to time. Exhibits illustrating the work of Moscow savants who have lived and worked in the universities of Great Britain and the United States are a special feature. One of those is Prof. Pavel Vinogradov, who has made the medieval history of England and Italy his special subject. He worked for some time at Oxford, and was honoured with a knighthood by the British Government. His colleagues elected the aged Sir Paul Vinogradov to the responsible post of chairman of an international commission charged with the preparation of a new edition of a dictionary of medieval Latin.

Other figures to which prominent reference is made at the exhibition are Prof. Peter Kapitza, who has been closely connected with both Soviet and British academic life, Pavlov, Prof. Samuel Harper, of the University of Chicago, and Sir Bernard Pares, of the University of London. A large section is devoted to the exchange of books between the University of Moscow and the principal universities of Europe and America. During the past two years the University of Moscow has received more than 4,500 scientific publications from 320 cities throughout the world.

Cultural and Scientific Mission in China

Dr. Joseph Needham, F.R.S., of the Cambridge Biochemical Laboratory, has recently accepted a mission of cultural and scientific co-operation, on behalf of the British Council, to China. In Chungking he will be attached to the National Academy of China (Academia Sinica). He will carry letters of greeting to Academia Sinica from the Royal Society and the University of Cambridge, and to other Chinese organizations from the appropriate British bodies. He expects to visit most of the Chinese universities, and to facilitate the supply of scientific apparatus and books from India with the help of the Indian Government. It is probable also that he may be able to help the interchange of scientific and technical information between China and the other United Nations. For this purpose he would be glad to receive any suggestions bearing on the problems of scientific liaison, or any questions of specifically Chinese relevance; after the end of the present month, he may be reached c/o British Embassy, Chungking, via Foreign Office, London.

Man-Power in Physics in the United States

The War Policy Committee of the American Institute of Physics has issued a report surveying the man-power problem in physics in the United States. It is stated that there are only 7,000 physicists in the United States, the large proportion of whom are doing vital war research. This leaves too few for the training of the large numbers of men needed for the operating and maintaining of technical mechanisms like aeroplane and submarine locators, signalling devices, anti-aircraft fire control, etc. The Committee estimates that some 200,000 men and women will require training in physics within a year. These will be mostly next year's college and university students, who expect to enter the Army or Navy reserve training courses to be carried out at these institutions, and they will have to be taught by staffs already considerably depleted for war research. The Committee urges therefore that every possible step be taken to increase physics man-power of the United States and to use the present supply in the most effective manner. It recommends the establishment of Government-sponsored teacher-training courses, the adoption of wise occupational policies by the Selective Service System, financial aid to qualified students so that they may continue and finish their studies (especially graduate students who are already taking a large part of the teaching load), and use of physicists in the Army and Navy only for work requiring their training. The Committee states that there is not sufficient understanding of the importance of physics in the war effort, especially on the part of the general public and of some local boards of the Selective Service. To remedy this, it is suggested that a public relations programme be commenced to educate the general public to the position, and to impress on students and teachers of physics the importance of continuing their work.

Control of Opium and Other Dangerous Drugs

MEETINGS in connexion with the international control in narcotics have just been held in London under the International Conventions concluded in 1925 and 1931. The Permanent Central Opium Board, which exercises, under the auspices of the League of Nations, the supervision over the manufacture of, and trade in, opium and other dangerous drugs in all parts of the world, has held its forty-first session. It was attended by Sir Atul Chatterjee, president (India), Mr. Herbert L. May, vice-president (United States of America), Sir Malcolm Delevingne (United Kingdom), Mr. J. H. Delgorge (The Netherlands), and Dr. George Woo (China). The Board carefully scrutinized the world position as it appears from the statistical reports sent in for the year 1941 by fifty sovereign States and some sixty-six dependencies and colonies and other territories. It also considered certain questions of policy and solutions of problems arising from the special circumstances of the War. Under the terms of the Conventions, the Board's report on its work is being sent to the Secretary General of the League of Nations.

The other international organization operating under the Conventions, namely, the Supervisory Body, has the task of examining annual estimates sent by Governments of their drug requirements, and members of it met for consultations to consider questions arising on the estimates for 1943, and issuing the Supervisory Body's annual statement on world requirements of narcotic drugs for that year.

Collaboration in the British Empire

THE Peter Le Neve Foster Lecture on "Empire Relations", delivered by Viscount Bennett before the Royal Society of Arts on June 3 (*J. Roy. Soc. Arts*, 90, 613; 1942), gives a lucid survey of the development of the relations between the parts of the British Empire from the sixteenth century to the organization of the present Imperial Conference system in 1907, when these conferences became a fixed method of consultation between the self-governing Colonies and Great Britain and one another. Mainly from a constitutional point of view, Lord Bennett gives an account of the further development of the system and its limitations, notably its failure effectively to promote Imperial development on scientific lines. Imperial conferences since 1907 have been concerned with almost every conceivable subject, including communications, patents, development of Empire resources, research, timber reserves, wool production, etc., but while they have afforded an opportunity for representatives of all the nations of the Commonwealth to meet one another and discuss personally Empire problems in the light of their experience and special knowledge of their own communities, they have led to no agreement upon any adequate method for providing continuous consultation on matters of common concern. Urging the need for an earnest effort to make the story of the Empire better known to the youth of Great Britain, Lord Bennett stresses the importance of providing the means for adequate and continuous consultation. This is essential for common action by the Governments of the Empire to attain a common end, and he suggests that a member of each of the Governments of the Overseas Dominions might be resident in London. Regular meetings between the Prime Ministers or representatives of their several Governments, utilizing air transport and with a permanent secretariat, might provide a solution of the problem.

A Proposed World Calendar

THE World Calendar Association, Inc., New York, has published details for a proposed new calendar to commence in 1945 ("The World Calendar—A New Calendar for a New World." Pp. 32. World Calendar Association, Inc., 630 Fifth Avenue, New York). On the basis of a 364-day year, the year is divided into four quarters, each of 91 days. The first month of each quarter contains 31 days and each of the others 30 days, and January, April, July and October contain each 31 days. Every year and in consequence every quarter begins on a Sunday, and it is suggested that the national holidays of every country can be arranged to come on Mondays, if the people wish it, thus producing long week-ends. Christmas Day falls on Monday every year, and it is suggested that Easter should be the second Sunday in April, that is, April 8. As a result of fixing Easter for this date, the other movable Christian festivals, Ash Wednesday, Good Friday, Ascension Day, Whitsunday, etc., would occur on the same date every year. Such a stabilization of the hitherto movable festivals would place Advent Sunday on December 3 and Trinity Sunday on June 3—exactly six months apart. The 365th day will be at the end of December and it is recommended that it should be designated as a World Holiday by all countries accepting the new calendar. This World Holiday is an extra Saturday, called the Year-End Day. Leap Year Day is placed at the end of June, in the middle of the year, and it is also an extra Saturday and a World Holiday. The beneficial effects of the reform are explained in connexion with the various phases of life—industry, labour, Government, law, finance, science, etc.; and an appeal is made to the citizens of different countries to lend their support to the scheme.

The Problems of the A-Type Stars

OTTO STRUVE and P. Swings have an article with this title in the August issue of the *Observatory* (No. 809, 64, August, 1942). Morgan pointed out about seven years ago that there is some physical factor other than temperature and surface gravity concerned in the production of the spectra of these stars. The theory of ionization has failed to solve the problem, and the authors are convinced that existing interpretations, which are very unsatisfactory, should be abandoned. They believe that a new solution should be attempted along lines which have been forced on them by the results of their recent work on stellar shells, Wolf-Rayet stars and planetary nebulæ. It is suggestive that certain peculiarities occur in that region of the sequence of the stellar spectra where the Lyman lines and the Lyman continuous absorption cause a large redistribution of the energy in the continuous spectrum. This redistribution has a profound effect on the continuous spectrum of an *A* star, as shown by the curve computed by Pannekoek for a temperature $T_0 = 8{,}480°$, and it must have a marked influence on the ionization as well as on the excitation of those elements the ionization potentials of which lie in the region of 12 volts. Research in recent months has led the authors independently to the conclusion that this physical dilution of radiation—as contrasted with the geometrical dilution observed in shells—plays a very important part in a number of problems, and various instances of this are given. A wide variety of unexplained observations are capable of interpretation along the general lines suggested by the authors, details of which are to be published in the *Astrophysical Journal.* Departures from thermodynamic equilibrium are now being emphasized by recent developments in stellar spectroscopy, in contrast to the long and successful period characterized by the use of thermodynamic equilibrium.

Infra-red Baking

A RECENT article by H. Seymour (*The Electrician*, August 21) surveys the present state of the technique of infra-red baking of industrial finishes. The article makes brief reference to early development and mentions that although first patented some seven years ago, radiant heating received little attention until adopted by the Ford Motor Co. It is emphasized that the rate of temperature rise depends primarily on the difference between the energy gain of the stock by absorption of radiation, and the loss of heat by re-radiation and convection; and that the temperature of the stock and its surroundings should be of the same order of magnitude. Depending on the linear absorption coefficient and absorptivity of the film, baking or heating may occur from the inside outwards, the outside inwards, or uniformly throughout the film.

A description is included of the various types of radiant heating lamps, and of their early development; reflectors and their surfaces; and the present trend of design. Reflector surface fouling by dust and fumes receives special mention, while reference is made to a new type of unit with a sealed lens which obviates cleansing, reduces the fire hazard, and avoids reflector surface damage. An intensity survey is included which discusses the possibilities of obtaining uniform energy intensities over surfaces normal to the lamps. The results of recent research into the infra-red absorption characteristics of various paint pigments ground in similar vehicles are given. The conditions for maximum utilization of electrical energy are examined and it is stated that this obtains when the air temperature is higher than the stock temperature. Vapour removal, performance ratio, maximum heat densities and oven arrangements are discussed, and the view is expressed that future practice will utilize radiant heat lamps augmented by auxiliary heaters.

Soldering Electrical Joints

AN article in the *Electrical Review* of August 28 describes the technique and selection of suitable materials. The process of soldering may be defined as the uniting of metals by means of an alloy melting at a lower temperature than their fusing points, as distinct from welding in a state of fusion. The solder alloys with the surface layers of the parts to be joined and the process is not simply one of adhesion. There are two broad classes of soldering, namely, soft soldering in which tin-lead alloys are mainly used and hard soldering in which alloys of copper-zinc (brazing) or of silver-copper-zinc (silver soldering) are employed. Soft soldering is used very extensively in electrical work and silver soldering to some considerable extent; brazing is rarely used. The electrical conductivity of soft and hard solders is considerably less than that of copper, varying with composition between approximately 9 per cent and 13 per cent for soft solders and 20 per cent and 40 per cent for silver solders.

Some or all of the following points must be considered in the selection of soldering processes for joints in current-carrying conductors. (1) Thorough cleansing and adequate heating, but not overheating. (2) As little solder as possible should be used, to obtain low electrical resistance and high mechanical strength. (3) Solder must not weaken at normal working temperatures. (4) Due to high centrifugal forces encountered in many electrical joints (for example, soldered commutator connexions), solder must be both strong and ductile. (5) Fluxes of a corrosive nature must be avoided, and flux residue easily removable. (6) Solders used for joining copper in the manufacture of cables must be strong and ductile to withstand the subsequent drawing operations; silver solders are generally employed. The article gives tables of solder compositions, properties and characteristics.

Health of the Swedish Army

ACCORDING to the August issue of the *Anglo-Swedish Review*, General Ivar Holmquist, Commander-in-Chief of the Swedish Army, has recently declared that, without going into technical details, he was sure that the Swedish soldier was one of the best in the world. What he lacked was only battle experience, but he was at least partly likely to make up for this by his excellent physique. Moreover, the nerves of the soldiers were in good order, they did not suffer from war weariness, the material was in first-class condition and had not been worn out by war, nor had the élite troops been decimated. Although it was deplorable that so much of the country's labour and resources had to be used for military purposes, the effort was not altogether wasted. For the general health of the nation it was important that the young men of twenty should receive one year's excellent physical training in the open air. During a recent tour of inspection among the mountains of Lapland, he was pleased to see with what vitality and enthusiasm these young men carried out a march of 13 miles in alpine terrain rising from 1,000 to 3,000 feet and then delivered an attack down a mountain slope carrying the heavy equipment of machine-guns and trench mortars which had been conveyed on sledges during the march.

Public Health in Peru

IN a recent article (*Bol. Of. San. Panamericana*, 21, 540; 1942) Dr. Constantino J. Carvallo, the Minister of Public Health, Labour and Social Welfare, gives a description of public health in Peru from December 1939 to July 1941. The chief health problems of this country are malaria, tuberculosis, children's diseases, venereal diseases and other contagious disorders. Health campaigns which have already begun include surveys, health examinations, vaccination, establishment of clinics and dispensaries, early treatment, rural hygiene, drainage of swamps and stamping out foci of infection, port and river sanitation and housing. A department of industrial hygiene was established in August 1940, while nutrition problems are handled by the National Nutrition Administration founded in February 1940.

Zoological Society of London : New Secretary

DR. S. A. NEAVE, C.M.G., O.B.E., director of the Imperial Institute of Entomology, has been elected honorary secretary of the Zoological Society of London to fill the vacancy caused by the resignation of Prof. Julian Huxley. Dr. Neave will hold office until April 1943, when the next annual general meeting will be held. Dr. Neave's work, especially in economic entomology, is well known. He was naturalist to the Geodetic Survey of Northern Rhodesia during 1904–5; entomologist to the Katanga Sleeping Sickness Commission during 1906–8 and entomologist to the Entomological Research Committee (Tropical Africa) during 1909–13. From 1918 until 1933 he was honorary secretary of the Royal Entomological Society and was its president in 1934–35.

Alphonse François Renard (1842—1903)

THE Belgian geologist Alphonse François Renard, who with Murray reported on the rock deposits from the bottom of the sea collected by the "Challenger" expedition, was born at Renaix in East Flanders on September 27, 1842. Educated at Rome for the Church, during 1866–69 he was superintendent at the Collège de la Paix at Namur, and then entered the Jesuit College at the old abbey of Maria Laach in the Eifel. Taking up the study of geology and chemistry, in 1874 he was made professor of those subjects at the College of the Belgian Jesuits at Louvain and a few years later was made a curator of the Royal Natural History Museum at Brussels. Though ordained a priest in 1877, he abandoned his intention of entering the Society of Jesus and separated from Rome, resigned his post at Louvain in 1882 and in 1888 was appointed professor of geology in the University of Ghent, a post he held until his death. In conjunction with Vallée-Poussin (1827–1904) he wrote on the plutonic rocks of Belgium. The Geological Society in 1885 awarded him the Bigsby Medal. He died at Brussels on July 9, 1903.

The Night Sky in October

THE moon is new on October 10d. 04h. 06m. and full on October 24d. 04h. 05m. U.T. The following conjunctions will occur during the month: Oct. 3d. 16h., Jupiter in conjunction with the moon, Jupiter 3° N.; Oct. 27d. 11m., Saturn in conjunction with the moon, Saturn 3° N.; Oct. 31d. 05h., Jupiter in conjunction with the moon, Jupiter 3° N. Occultations of naked-eye stars during the month are as follows, the times referring to Greenwich :

d.	h.	m.			
6	03	44·3	18	Leonis	*R*
26	21	52·3	γ	Tauri	*D*
	23	02·1		Tauri	*R*
27	03	44·7	θ′	Tauri	*D*
	04	24·6		Tauri	*R*
27	04	37·8	75	Tauri	*R*
27	07	51·7	α	Tauri	*D*

On October 11 Mercury is in inferior conjunction and on October 26 will be at an elongation favourable for northern observers, rising about 2h. before the sun. Venus is too close to the sun to be observed during the month. Mars is in superior conjunction on October 6 and is not well placed for observation. Jupiter is favourably placed for observation after midnight, and Saturn, near Aldebaran, rises early in the night, southing about 3h. in the middle of the month.

Announcements

SIR D'ARCY THOMPSON, professor of natural history in the University of St. Andrews, has been elected president of the Royal Scottish Geographical Society, in succession to Lord Rosebery.

THE Lord President of the Council has appointed Sir Lawrence Bragg, Prof. J. E. Lennard-Jones, Dr. A. McCance and Sir Raymond Streat to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research from October 1. Dr. G. M. B. Dobson and Mr. S. K. Thornley will retire from the Council on completion of their terms of office on September 30.

By an Order of the Committee of Privy Council, made after consultation with the Medical Research Council and with the president of the Royal Society, Prof. D. Keilin, Quick Professor of Biology in the University of Cambridge, and Sir Henry H. Dale, retiring director of the National Institute for Medical Research, have been appointed to be members of the Medical Research Council in succession to Prof. L. J. Witts and Prof. C. R. Harington, who retire in rotation on September 30. By the same Order, Sir Charles Glen MacAndrew, M.P., has been appointed to be a member of the Council in succession to the Right Hon. James Gray Stuart, M.P., also from October 1.

DR. HARRISON E. HOWE, editor of the *Journal of the American Chemical Society, Industrial and Engineering Chemistry*, and a trustee of Science Service, has been awarded the Chemical Industry Medal for 1942 by the American Society of Chemical Industry.

MR. F. H. WYNNE retired from the post of H.M. chief inspector of mines on September 20, on reaching the age limit. He is succeeded by Mr. J. R. Felton, who has been the deputy chief inspector since the end of 1937.

DR. FÉLIX AGUILAR, director of the National Observatory, La Plata, Argentina, writes that one of his colleagues, Mr. Gualberto M. Iannini, has undertaken to compute a definite orbit of Comet Whipple, 1942 *a*. He would be very grateful for data, especially from observatories in the northern hemisphere.

THE opening meeting of the new session of the Iron and Steel Institute will be held on October 13, at 2.30 p.m., in the lecture theatre of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2, when the president, Mr. W. M. Selvey, will present a short address. This will be followed by the presentation of the Melchett Medal for 1942 to Dr. Arno Carl Fieldner, chief of Fuels and Explosives Services, United States Bureau of Mines. As Dr. Fieldner cannot be present, the medal will be accepted on his behalf by the United States Embassy. The Melchett Lecture, entitled "The Analysis and Testing of Coal in Relation to its Properties and Utilization", will, in Dr. Fieldner's absence, be delivered in the form of a talking film of himself reading it, which will be reproduced in the lecture theatre.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Functions of the Research Associations

SIR LAWRENCE BRAGG's valuable and thought-provoking address at the Royal Institution on March 26 (NATURE, July 18, p. 75), under the title "Physicists during and after the War", readily recognizes the value and status of industrial research. This will be welcomed by many who are connected with industry, and who often know more of what is going on in the universities than the universities do of what is being done in industry. Unfortunately, there is no doubt justification for his assumption that there does exist, among many university professors, a feeling that industrial research is of an inferior kind. This is mainly through lack of knowledge of the scope and kind of work now covered by the expression 'industrial research'.

Reference is made by Sir Lawrence to the ardent reforms that are in the air, and he discusses among other things the merits of one of the proposals—that new institutions for pure research divorced from teaching should be founded. Is the field not already covered ? We have first the celebrated schools of university research, where pure research is carried on usually without any thought of practical application. On the other hand, we have the research laboratories of industrial firms where research is mainly applied, except in the bigger ones (for example, some of those connected with the electrical, metallurgical, textile and chemical industries) which also carry out fundamental work. The missing gap between these two was filled by the inauguration, twenty-four years ago, of the Research Associations. One of the special features of a Research Association is that it is the only organization in Great Britain having a bird's eye view of an industry's problems, and that can therefore formulate its research programme in the best interests of the industry as a whole. I do not see that any advantage would be gained to the State by the formation of a fourth class of research institution of the type to which Sir Lawrence refers, and of the value of which I gather he himself is sceptical. One example of this kind is the suggestion made by Prof. J. D. Bernal in his book "The Social Function of Science" for the foundation of a comprehensive "Fibre Institute". Would such an institution be in a position to do better work than is already done ? Without mentioning the mass of research work on fibres carried out (and published) by the textile Research Associations, could the fine work done, for example, by Prof. J. B. Speakman and by Dr. W. T. Astbury at the University of Leeds, be easily improved upon ? In so far as such work suffers from lack of equipment, this could be met by giving larger grants for this purpose to existing institutions and not by forming new ones.

Sir Lawrence thinks that the general conditions under which Research Associations work militate against the production of really fundamental ideas. He compares the Research Associations unfavourably in this respect with the universities on one hand and the industrial laboratories on the other. I do not think this is really so ; it may be true that the Research Associations as a whole have not devoted as much of their resources to fundamental research as would be desirable, but this is not in my opinion due at all to their organization and the intermediate position they hold between the universities and industry. I rather take the opposite view that this position gives them a unique opportunity to carry out the highest class of fundamental creative work, with contacts with the universities and at the same time a comprehensive mental picture of the central problems of their own industry, while completely free from the rush and bustle associated with industrial production. I suggest that if any of the Research Associations have failed to produce a fair quota of new fundamental scientific knowledge, the explanation is to be sought in lack of resources and not in their organization or position in the scheme of things. It is of extreme importance that a Research Association should maintain a proper balance between the accumulation of fresh knowledge and development of new ideas on one hand, and their application to their own industry on the other. Fundamental scientific work must go on simultaneously with the application of knowledge previously gained. Without big resources it is very difficult, if not impossible, to maintain this condition.

There are still a great number of university teachers who do not realize that research in pure science is not confined to the universities, but no one really familiar with the work of the Research Associations (and possibly, in particular, the larger ones) would, I think, deny that a great deal of purely scientific research is carried out with no other immediate aim than the accumulation of fresh knowledge and with no limitation of the freedom of the individual worker through too much 'direction' from above. Indeed, in one sense I would say the young graduate, after joining a Research Association, is more free than the raw graduate in a university laboratory, who commonly obtains his research training within the limits of his professor's own specialized (and sometimes narrow) field—a system which has led in physics to something akin to inbreeding, and to the scarcity of young physicists who have a first-class general knowledge of 'properties of matter' physics.

Sir Lawrence emphasizes the idea of a Research Association as being "ideally a permanent laboratory with special equipment, but with a changing population, not as being a permanent body of men", and goes on later to refer to the opposite side of the picture "only too commonly seen", of research being "directed" by a Committee, which is too impersonal a body to direct research, and the members of which "are generally too busy and important to give the necessary time and attention to detail".

Too much emphasis can be placed on the idea of a changing population, though I agree that augmentation from time to time of the staff from outside by fresh, unprejudiced minds is highly desirable. But such changes should generally, though not necessarily always, be among the younger research staff, rather than the more senior men. It is not always realized that nearly all the Research Associations are unique in that they serve the older industries which were flourishing trades before industrial research had ever been heard of. It follows from this that one of the first essentials to the success of a Research Association is the complete confidence of the technical men in the industry in the Association's most senior staff, and this can only come about—in the larger industries in any event—through much personal contact and recognition by the industrialists of the intimate knowledge these senior men have acquired through close study of the industry over a great many years. Constant changes among senior men would do a Research Association a great deal of harm.

As regards research being run by committees, while it is true that research committees do exist, and that they approve the research programme, I have never heard of a case where fundamental scientific work has been hindered through this system. From the very constitution of these committees, the suggestions which come from them are, so far as my knowledge goes, nearly always concerned with *applications* of knowledge the Association has already gained—a field in which they are eminently qualified to make suggestions, often valuable ones.

Sir Lawrence's suggestion that there should be more contacts between research workers in the universities and those in industry has great possibilities. I would therefore extend a cordial invitation to any professors who feel an urge to write about Research Associations, but who may possibly feel that before doing so they would like to know more about them, to visit the Shirley Institute, and form their own opinion of the purely scientific researches carried on there normally in peace-time.

F. C. Toy.

British Cotton Industry Research Association,
Shirley Institute,
Didsbury,
Manchester.
Sept. 1.

I am too conscious of the lack of contact which has often existed between the university and the industrial researcher not to sympathize with much of what Dr. Toy says on the functions of the Research Associations, and one cannot resent the mild sting which he has permitted himself to add to its tail!

He mentions two difficulties with which the Research Associations have to contend: lack of resources and the fact that for the most part they serve the older industries. As regards the first, it has often been pointed out what a small fraction of our national income we devote to research, as compared with other industrialized countries. As regards the second point, the older industries have a wealth of technical experience, and it is an arduous task for the man of science, using his fundamental knowledge, to surpass the skill and lore acquired by long practice.

Dr. Toy rightly stresses the undoubted fact that in spite of these handicaps much fine original work is done in the Research Associations. Yet on re-reading my own article, I do not feel that Dr. Toy's views are in conflict with its main points, and hope that readers of Nature will come to the same conclusion. In discussing physics in industry, the last thing I had in mind was a criticism of any particular body of men. I expressed a conviction, and reaffirm it, that we have not yet discovered the best way of applying our great resources of native scientific ability to the strengthening of our industrial position.

W. L. Bragg.

Encouragement of Research in Industry

The point made by Sir Lawrence Bragg[1], and again by Mr. Benham[2], concerning the need for freedom for scientific work from other interferences, cannot be too highly stressed.

The fact that scientific workers are generally blessed with a good fund of 'common sense' often results in many jobs in industrial establishments being passed over to them for attention, jobs which more properly should be dealt with by other departments of the organization. Their greater technical knowledge of the jobs means that they are better done—but only at the cost of interruption of their proper research or development work. Too often also they are called upon to put right the mistakes of other sections of the business—mistakes which should not have occurred if adequately trained staff had been employed in those sections. Financial considerations, however, doubtless influence this in many instances.

Reluctance of the production staffs to make use of the developments of the research workers is not confined to the senior supervising staff. In many cases it extends down to the foremen, to the charge hands and to the workers themselves. It can only be overcome by the friendliest co-operation between both sections. This co-operation is seldom easy to secure, because they generally talk in different 'languages', and think in different terms.

A good liaison engineer (but one who has no particular flair for research), between the development or research section and the production departments, is probably the best solution. If he has had a little post-graduate research training he will appreciate the finer points and needs of the scientific aspects of the problem; while if he is a good engineer he will be able to translate these into the necessary applications in the manufacturing departments and see that their difficulties—and they will always have difficulties with any new process—are given sympathetic attention.

The suggestion made by Mr. Benham that more use should be made of shorthand typists in research laboratories is a good one, and I should like to endorse it heartily. Provided that they are reasonably intelligent and can be trained to present the data in a proper form and can take some useful action regarding other matters on which they may be given notes during the progress of some investigation, they can be a great asset. Good ones for this type of work are not easy to find. I would suggest further that if mechanical calculating aids are available—and at the very least an adding machine should be 'on tap' in every laboratory—they should be taught to operate them so that their sphere of utility to the research worker can be much increased. In many cases, however, it does not prove easy to convince the management of needs such as these.

This, again, is another argument in favour of Sir Lawrence Bragg's plea that all laboratories should be given authority for certain expenditure entirely without reference to any outside control. The researchers will then quickly get the equipment most useful to them; without the wearisome arguments necessary to justify it to others—who cannot appreciate the real needs of the moment. Only too often is work spoiled or improperly completed on this account.

Finally, as Mr. Benham says, give the researchers more responsibility. If expenditure on the research is justified at all, it is all the more justifiable that the researchers should be given the responsibility and authority to see that their work is properly applied in the production departments. They must rank equal with the production managers and not be entirely subordinate to them.

Philip R. Coursey.

Nutteries,
Liss, Hants.

[1] Nature, 149, 75 (1942).

[2] Nature, 150, 235 (1942).

Homology of the Campaniform Organs on the Wing of *Drosophila melanogaster*

In the normal wing of Drosophila the campaniform sensilla have been noted by McEwen[1], and have been shortly described by Hertweck[2] who termed them "*kuppelformige Organe*". They are arranged in well-defined positions which include several large groups at the base of the radial vein; single organs are found more distally on the first and third longitudinal veins and the anterior cross-vein (Fig. 1*a*). These organs show considerable variation in size, those at the base of the wing being the smallest. When viewed from the side a large sensillum from the distal part of the radius is seen to consist of a cuticular dome set in a socket-like elevation of the cuticle (Fig. 2*b*). Smaller sensilla from the base of the wing have a similar, though smaller, dome, but the socket-like part of the complex is much less conspicuous and seems to be represented by the rim of a shallow saucer-like depression in which the dome is inserted. All the organs are circular or nearly so. In section their structure is seen to be typical of this type of sensillum (Fig. 3): each is innervated by a single sense cell from which arises a 'sense fibre' which is inserted on the inner side of the dome; the sense fibre with the exception of the tip adjacent to the dome stains deeply with hæmatoxylin, a property which is shared by the inner lining of the dome (the "*Polstermasse*" of German authors).

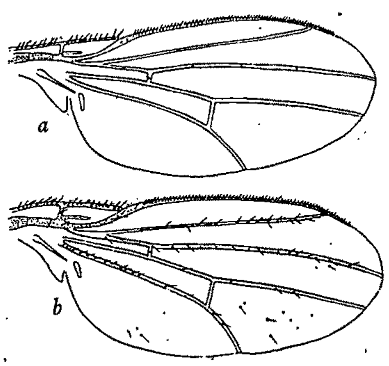


Fig. 1.

a, Diagram of the dorsal surface of a normal wing showing the positions of bristles and campaniform sensilla—the latter are indicated by dots; *b*, the same for a 'hairy' wing. In both, certain ventrally placed sensilla and a large group of sensilla on the extreme base of the wing are omitted.

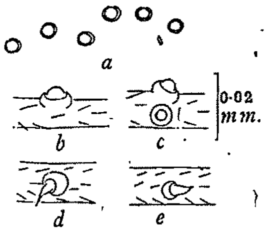


Fig. 2.

a, Surface view of part of a group of small campaniform organs on the base of the radius; *b*, side view of a normal large campaniform organ from the distal end of the radius; *c*, a reduplicated organ: *d–e*, structures intermediate between campaniform sensilla and bristles; *c–e* are from a 'hairy' wing.

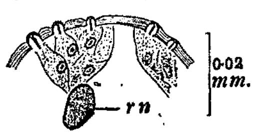


Fig. 3.

Transverse section through a group of small campaniform organs on the base of the radius in 'hairy wing'; *rn*, radial nerve.

The non-allelomorphic genes 'hairy' (*h*,3-26.5) and 'hairy wing' (*Hw*,1-0·0), as is well known, control the production of extra bristles on the thorax and wing of Drosophila; in addition, they also exert a very considerable effect—and in general the effects of both genes are very similar—on the wing campaniform organs. This does not appear to have been previously recorded. In these mutants the number of campaniform organs on the wing is greatly increased, for example, a typical 'hairy' wing may carry more than 150 organs compared with the normal complement of some 85. Most of the extra organs are found on or near the base of the radius, although a variable number occur more distally on the other veins or scattered in irregular groups on the intervein membrane (Fig. 1*b*). The most interesting effect, however, concerns the large distal campaniform sensilla, many of which are transitional in form between normal organs and typical bristles (Fig. 2 *d–e*); in these the socket-like element remains unaffected but the dome is produced into a small spinous projection. All intermediate stages between normal campaniform organs and fully formed bristles can usually be found on a single wing.

The derivation of the various types of insect sensilla from a central type such as the trichoid sensillum or bristle has sometimes been suggested. In the case of the campaniform sensilla Snodgrass[3] suggests that the bristle may have been lost but the socket retained. From the evidence outlined above it would appear that both elements of the apparatus are retained and that the dome of the campaniform organ is the homologue of the bristle. Unfortunately, the cells which give rise to the campaniform organs are not present in the adult, and, owing to their small size, it has not yet been possible to identify them with certainty in the developing wing. It is known[4], however, that in Drosophila, as in other insects, normal bristles are produced by two cells, one of which, the trichogen, secretes the bristle proper, while the other, the tormogen, gives rise to the socket. It is not improbable that two cells are also concerned in the formation of a campaniform sensillum and that one secretes the dome and the other the raised rim or socket-like part of the complex. When these organs are relatively small as at the base of the wing in Drosophila it is possible that the homologue of the tormogen fuses with the general cuticle or produces at most a shallow rim, rather than secreting a discrete socket-like structure such as is found in the more distal organs. The immediate cause of the normally strictly alternative type of secretion—campaniform dome or bristle—is not clear, but the obvious difference in the amount of cuticular material present in these elements is likely to be reflected in the respective sizes of the formative cells concerned.

These same organs have been wrongly referred to by me as "chordotonal organs"[5]. Observations made on the sensilla and conclusions drawn remain, however, unaffected.

A. D. Lees.

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Sept. 2.

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[1] McEwen, R. S., *J. Exp. Zool.*, **25**, 49 (1918).

[2] Hertweck, H., *Z. wiss. Zool.*, **139**, 559 (1931).

[3] Snodgrass, R. E., "Principles of Insect Morphology" (McGraw-Hill, 1935), p. 514.

[4] Lees, A. D., and Waddington, C. H., *Proc. Roy. Soc.*, B (in press).

[5] Lees, A. D., *J. Genet.*, **42**, 115 (1941).

Feeding of the Common Toad

THE accompanying photographs of the feeding of the common toad (*Bufo vulgaris*, Laurenti) supply, I believe, for the first time an accurate description of the tongue movement in an Anuran. The movement in the frog is similar, but I have not so far obtained such satisfactory photographs of it. Most modern text-books assume that protrusion of the tongue is accomplished by lymph pressure. The evidence for that theory is slight[1], and these photographs argue against it and in favour of a muscular mechanism, because (1) the time of protrusion is shown to be so short (sometimes less than 1/20 sec.); (2) the tongue and floor of the mouth show no signs of inflation; (3) there is a distinct constriction at the base of the tongue when viewed from above in the fully extended position (see Fig. 2). These features, and others, suggest a muscular mechanism similar to that proposed by Gaupp[2] on anatomical grounds; with the probability that purely intrinsic muscles play a larger part than he thinks, especially in the unrolling of the tongue and in the first part of retraction. It is still possible that lymph pressure may play a subsidiary part.

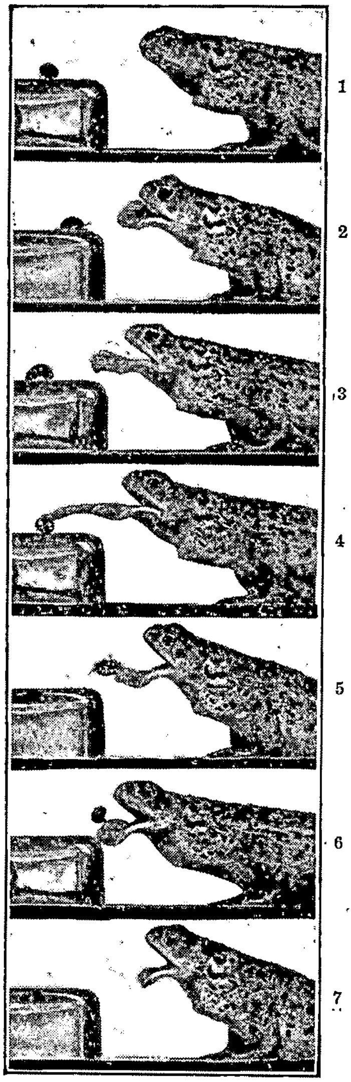

Fig. 1.

TOAD FEEDING; FROM SIDE. RECONSTRUCTED SERIES; NOS. 1, 4, 6 AND NOS. 2, 5, 7 ARE CONSECUTIVE FRAMES OF TWO SHOTS. FIG. 2 WAS TAKEN SIMULTANEOUSLY TO THE LAST OF THESE SHOTS. THE PREY IN ALL CASES IS A WOODLOUSE.

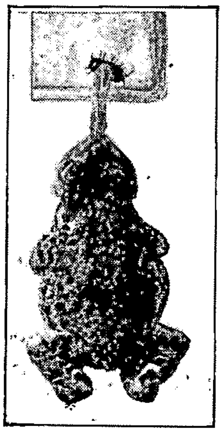

Fig. 2.

TOAD FEEDING: FROM ABOVE. TONGUE FULLY EXTENDED.

The entire movement occupies little more than 1/10 sec., divided nearly equally between protraction and retraction. The dorsal surface (at rest) is here only elongated to about eight sevenths of its length at rest, though other photographs show that it can be elongated slightly more than that. In its other dimensions there is very little change, except that it is slightly narrower when seen from above. The length of the protruded tongue in this female, which measures 3 in., is 8/10 in., from the tip of the lower jaw. Fig. 1, No. 5, shows from the legs of the prey that the tip of the tongue is rotated through 180° at the beginning of retraction.

O. R. BARCLAY.

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Sept. 7.

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[1] Hartog, M., *Ann. Mag. Nat. Hist.*, **7**, 7 (1901).

[2] Gaupp, E., *Anat. Anz.*, **19** (1901).

Response to Colour in Birds

APART from some experiments by Marples[1], little work appears to have been done on the colour awareness of birds in their wild state. By colour awareness is meant the ability to detect and react to light of widely differing wave-lengths. The possibility that such recognition may, in birds, involve merely the detection of different intensities of a single shade has not been overlooked, but is contra-indicated by the experiments described here. These experiments have been carried out by utilizing the instinct of nest-sanitation whereby most birds, and especially those of the Passerine order, keep their nests free from contamination by the excrement of the young. This instinct has been shown by Smith[2] to be of the same order of strength as that to feed the young, and the provision at the nest of artificial fæces of various colours gave a ready means of testing the response to colour in certain species. These artificial fæces were made from 'Plasticine' moulded into the shape and size of a fæcal sac, and spectroscopic analysis of the samples employed gave the data shown in Table 1.

TABLE 1.

Colour	Brightness factor	Hue wave-length ($\mu\mu$.)	Saturation
White	0·586	578	0·156
Yellow	0·362	578	0·448
Green	0·222	549	0·348
Red	0·134	492*C*	0·228
Purple	0·116	566*C*	0·006

(*C* = complementary colour.)

The colours are thus far from pure, but this was to be expected from a substance like pigmented 'Plasticine'.

The artificial fæces were placed on the rim of the nest, in a similar position to that used by the nestlings. Their arrangement was quite random, and was changed for each trial. Observation of the order of removal of the artificial fæces was made from a 'hide' in close proximity to the nest. If birds were colour-blind, the order of removal would be in the order of decreasing brightness factor, since the brightness factor is defined as that attribute of a colour in respect of which it can be classed as equivalent to some member of a series of greys ranging between black and white. The results of trials at nests of the meadow pipit (*Anthus pratensis*) and the yellow wagtail (*Motacilla flava flavissima*) are given in Table 2, and show no correlation with the brightness factor.

TABLE 2. ORDER OF REMOVAL OF DIFFERENTLY COLOURED ARTIFICIAL FÆCES FROM NESTS. ROMAN FIGURES BY ♂ BIRD; ITALICS BY ♀.

Species	Trial	Red	Yellow	Green	Purple	White
Meadow Pipit	*a*	4	*3*	1	Ignored	*2*
	b	*4*	*3*	1	5	*2*
	c	*5*	*3*	2	4	*1*
	d	*4*	3	1	Ignored	*2*
	e	*4*	3	*1*	*5*	*2*
Yellow Wagtail	*a*	5	1	4	3	*2*
	b	5	1	4	3	2
	c	4	1	5	2	*3*
	d	5	2	4	1	*3*

Fig. 1 shows the female meadow pipit removing, during trial *c*, the yellow (*Y*), while the red (*R*) and purple (*P*) fæces remain on the rim of the nest. Fig. 2 shows the male yellow wagtail removing, in trial *d*, the yellow (*Y*), while white (*W*), green (*G*) and red (*R*) remain.

It is evident that, to the meadow pipit, green must appear as a very bright colour, since in four out of five trials it was taken as first choice. Yellow occupies an intermediate position and red and purple are last choices; purple particularly failing to attract attention. With the yellow wagtail, on the other hand, the order of choice was strikingly different. With this pair of birds, the female refused all the artificial fæces except the white ones, but the male readily removed them all. His first choice was yellow in three out of four trials, after which he took purple or white. In trial *d* purple was first choice. Green, on the other hand, was the penultimate, and red the last choice, three times in four. These results are in striking contrast to those obtained with the meadow pipit, especially in relation to the significance of yellow and purple. Pipits and wagtails are both Motacillidæ, but while the former tend to have dull brown plumages, the wagtails are often brightly coloured with yellow and blue frequently predominating, and although much more experimentation is needed before any conclusive correlation can be made between the colour awareness of birds and their plumage colours, the very obvious pointer to such a correlation cannot be ignored, especially when it is remembered that the yellow wagtail is a sub-species of the basic blue-headed form, *Motacilla flava flava*.

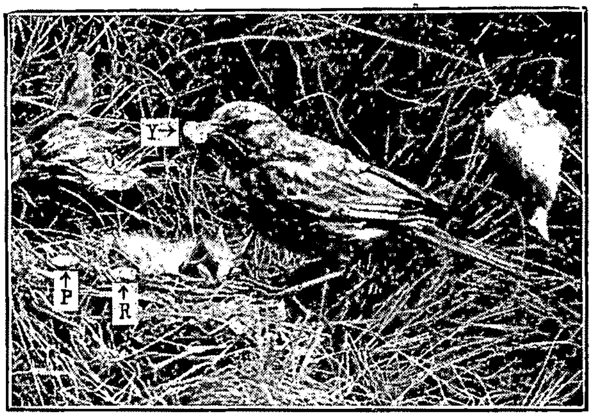

Fig. 1.

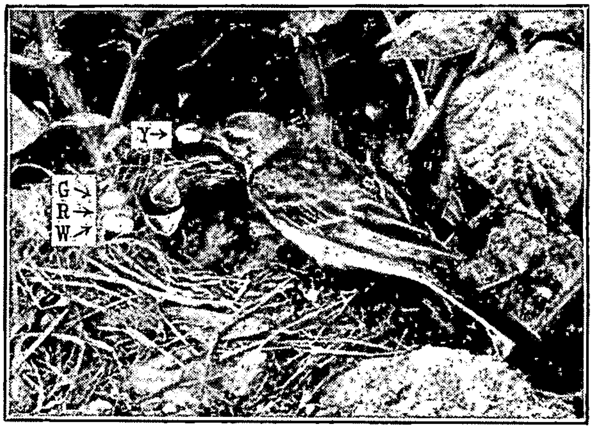

Fig. 2.

The use made of the brighter-coloured parts of their plumage by male birds in nuptial and aggressive display is well known, and in this connexion the work of Lack[3] on the robin (*Erithacus rubecula melophilus*) shows that for this bird, in contradistinction to the two species above, red is a highly significant colour.

These, and other related experiments, will receive detailed treatment in another place.

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Aug. 26.

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[1] *British Birds*, **25**, 34 (1931); **26**, 238 (1933).

[2] *British Birds*, **35**, 120 (1941).

[3] *Proc. Zool. Soc.*, **109**, 169 (1939).

A False-Ring Pattern in Larch

DURING the course of the Timber Felling Survey organized by Prof. H. G. Champion, and undertaken for the Forestry Commission by university research parties during the summers of 1940 and 1941, it fell to my lot, as plant pathology member of the Bristol Party, to examine and make counts of the annual rings on felled timber, chiefly European larch.

Such counts, made in the field, proved at first very unreliable owing to the difficulty of determining false, partial or missing rings, and of interpreting the outer rings of suppressed trees. The practice was therefore adopted of taking back from each plot at least one complete cross-section of a butt which was planed and examined in the laboratory. This resulted in the discovery that in nearly all the butts of European larch examined, taken from all parts of the area covered by the Bristol Party, there was a general and recognizable pattern formed by the false rings.

Fig. 1*a* records the percentage of reliably dated annual rings from 1900 to 1940 which showed one or more false rings, including as such everything from slight traces to complete additional rings. It is based upon examination of 105 butts of European larch 25–60 years old. If the false rings on single butts are plotted to the same scale, as shown in Fig. 1*b*, each of the plans so formed will usually fit the master plan best in one position, that corresponding to the correct dating. Exceptions are found in trees with completely unchecked growth, which may have few or no false rings, old trees in which the outer part covered by the established pattern is suppressed, and a few 'oversensitive' butts in which there are so many false rings that the pattern is swamped. In general, the number of false rings appears to vary inversely with the soil depth.

Not only the occurrence of the false rings, but also their number, appearance, and position in any given year's growth, are all of value, and there is now no difficulty in fitting into the pattern any 30- to 50-year-old butt from the south-west region which shows a fair number of false rings. Older trees also show characteristic false rings during their period of maximum ring-width, and the pattern has been tentatively extended back to 1860, but is unreliable owing to the small number of trees examined.

The area from which butts were examined extends very roughly fifty miles round Bristol. The five false-ring plans shown in Fig. 1*b* are from single butts taken from the following localities:

(A) White Hill, near Monmouth.
(B) Pump Ground, Stanway Estate, north-east of Winchcomb, Glos.
(C) Old Hill, near Wraxall, 7 m. west of Bristol.
(D) Huish Cleeve, near Wiveliscombe, Somerset.
(E) Grange Hill Farm, near Basingstoke, Hants. (from a section kindly sent to me by a member of the Oxford Party).

The pattern varies in characteristic fashion from one district to another, but the similarities throughout the area remain more striking than the differences.

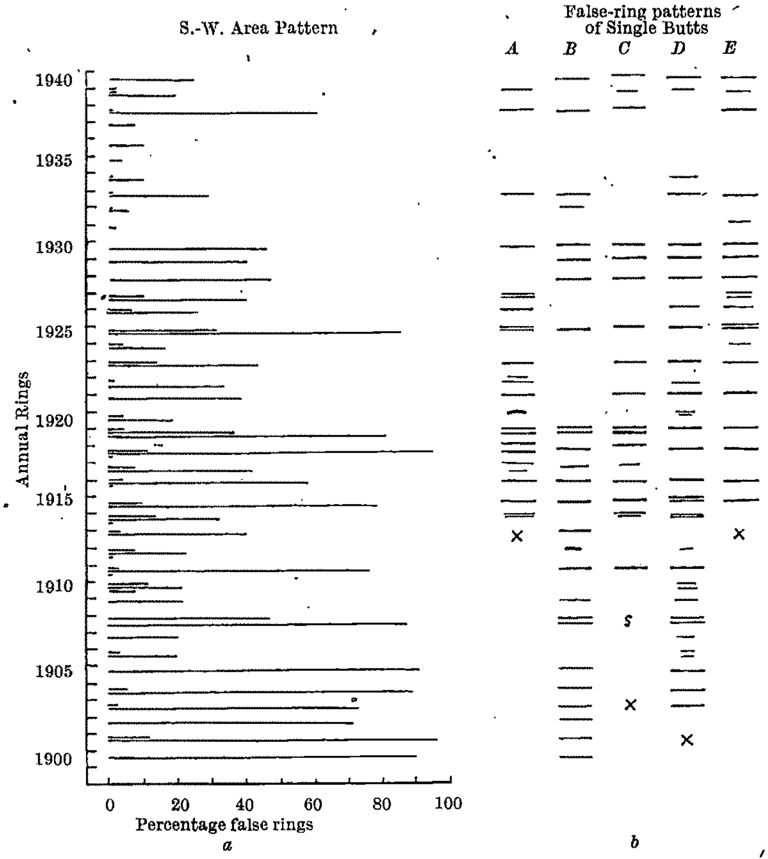
A majority of the butts examined came from the northern part of the area: 26 from the Wye Valley and Dean area, 36 from the Stanway Estate on the Cotswold plateau, 12 m. north-east of Cheltenham, 23 from a few miles west of Bristol, and the remaining 20 from widely scattered places in Somerset, west Wilts, and a few from as far east as Basingstoke and King's Somborne, Hants. The pattern shown in Fig. 1*a* has therefore a strong bias in favour of the local patterns in the northern part of the area. Nevertheless, the chief elements are present throughout the area and it will be of interest to see how widely they extend beyond it.

The most frequent and conspicuous false ring is found in 1918, about the centre of the year's growth; others are in 1938, 1925 (often double), 1919 (often double), 1915 (early central), 1911, 1908 (wide double), and the years 1900–1905, in which, however, the percentages are less reliable owing to the smaller number of records.

Once the probability of occurrence, and the typical position and appearance of the false rings in each year's growth had become known, the pattern was found to be of great practical use in the field. For example:

(1) It provided a check on the ring count, often revealing missing or inconspicuous annual rings which had not been seen or had been misinterpreted.

(2) It gave the ages of trees with suppressed outer rings, and of sections below the felling cuts which did not reach the outside.



×, first year of growth; *s*, annual ring suppressed.

(3) It enabled the outer ring on fairly recently cut timber or stumps to be dated with certainty, and also gave the dating of rabbit scars and other injuries.

(4) Where enough records had been taken to establish a local pattern it enabled unlabelled sections of butts to be referred to their correct sites.

Nineteen butts of Japanese larch show the same general pattern, with a few differences in emphasis; for example, the 1916 false ring is more frequent than the 1915. Other conifers show the 1918 ring, but the false rings, especially in spruce, are less distinct than in larch, and enough material for the formation of a pattern has not been studied.

It is to be hoped that comparison of the pattern with meteorological records will give some information on the effect of climate on the growth of wood and the formation of additional rings. The relationship, however, is unlikely to be simple. Attempts to establish a pattern for annual ring-widths, on the lines originated by Douglass and co-workers in the southern United States, failed completely even with trees on the same site. This was not surprising, as moisture can rarely be a limiting factor in the south-west district of England. Certain annual rings, however, notably those for the drought years 1911 and 1921, are often recognizable, apart from false rings, by their relative narrowness, and the firm, narrow outline of the autumn wood. In a damp, variable climate, it is the composite picture presented by the balance and distribution of the large- and small-celled elements in the wood of each successive year's growth, which makes a perceptible pattern worthy of further study.

Once the general climatic pattern is firmly established, the local variations from it will give useful information about soil conditions and the rooting system, and defoliation due to exposure, insect attack, or other local factors. It can scarcely be over-emphasized that the whole history of a tree's growth in relation to its environment is recorded in its wood, and that it needs only the separation of the general from the special elements in that record to make it intelligible.

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The So-called 'Granite Axial Core' of the Himalaya

From time to time there appears in various contexts reference to the predominant mass of granitic rock which, it is claimed or supposed, forms the vast bulk of the Great Himalayan Range, and particularly of its highest peaks. In his presidential address to the twenty-ninth Indian Science Congress, 1942, entitled "The Making of India", Mr. D. N. Wadia said: "The sublime snow-capped peaks of the Himalaya from Mount Everest to Nanga Parbat, all are built of this axial granite core", etc. Now specifically, neither Everest nor Nanga Parbat is composed of granite, although veins of granite-pegmatite or -aplite are fortuitously to be found within their essentially sedimentary constitution, which in both cases is made up of slate, quartzite or siltstone, limestone and schist of varying kind.

The time-honoured, but mistaken, view that the main Himalayan axis is thus composed of granite, or intrusive gneiss, is largely due to the early work of General C. A. McMahon, and other investigators, who did not penetrate far into the inner recesses of the main range, and moreover were mostly concerned with its north-western end. Exploratory expeditions of recent years both in the Central and in the Eastern Himalaya have, however, revealed that granite is nothing like so ubiquitous as has been supposed. In the Central Himalaya of Garhwal and Kumaon, in the region dominated by the great peak Nanda Devi, 25,645 ft., and also extending into Nepalese territory, altered sedimentary rocks such as slates, quartzites or siltstones, with crystalline limestone, compose the greater number of the high peaks which have so far been examined in the main range. The same is the case in the Eastern Himalaya, from the neighbourhood of Gosainthan, the great summit on the northern border of Nepal, through Mount Everest and its satellites, and all along the Sikkim- and Bhutan-Tibetan frontier: we find slates, siltstones and limestone—shore facies of the ancient Tethys Sea—constituting the succession out of which the high peaks have been carved. Para-gneisses and -schists are to be found deeply in the lower parts of many of these mountains, but undoubted ortho-gneiss or granite is restricted to the base of the range in certain districts, with granite veins extending upwards in some areas into the sedimentary series.

I may add that this note has been prompted by Mr. Wadia himself, with whom I recently discussed the matter in India, and its intention is to bring before a wider scientific public than geologists alone what has been one of the misconceived ideas of the nature of the Himalaya. Further details of this matter will, it is hoped, shortly be published elsewhere when military duties permit. The recent disastrous loss at sea of field-notes and partially completed papers relative to a large part of my work during three expeditions in the Himalaya will, however, quite preclude anything like a satisfactory rewriting of the vanished papers on Structure, Glaciology, etc.

N. E. Odell.

Clare College,
Cambridge. Aug. 26.

The Slide Rule Cursor

It is convenient to be able to check quickly whether the line of a slide rule cursor is accurately at right angles to the scale. We can test the correspondence of a number and its square, but if "log log" scales are available it is preferable to use them as, being further apart, the test is more sensitive.

I have found that 1·55 and 80·0 are almost exactly opposite each other and may be used for the test. The error, being 0·013 mm. in a 10-inch scale, is negligible.

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Aug. 31.

Commission of Forestry Research in Africa

Action which, it is hoped, may give rise to a notable advance in the application of the principles of scientific forestry to the practical affairs of the African continent has recently been taken. I write as Editor of the *Journal of the Royal African Society*, which has on several occasions in recent years reflected the strong interest of that Society in the problem of deforestation and soil erosion in Africa by publishing studies of it—notable among them having been contributions by Prof. E. P. Stebbing.

It occurred last year to Prof. Stebbing that the presence in Great Britain of the Belgians and the Free French, controlling between them territories which, with those controlled by Great Britain, form a belt across the whole of Central Africa, offered a unique opportunity for international study of this problem as a whole, which might pave the way in due course to concerted international action.

The Royal African Society was glad to use its good offices to this end, and, the Belgian Colonial Minister and the Free French National Commissioner for Colonies and the Netherlands Minister for Colonies giving their cordial support, an unofficial International Commission of Research, set up to study deforestation and erosion in tropical countries, came into being under the auspices of the Royal African Society, with membership as follows: Prof. E. P. Stebbing (*chairman*); Governor-General Richard Brunot, governor of Mauritania and Chad; Count P.

de Briey, territorial administrator and assistant provincial commissioner, Belgian Congo; L. Borremans, agricultural adviser, Belgian Embassy in London; A. Muhlenfeld, head of the Department for West Indian Affairs, Netherlands Ministry for the Colonies; Sir William Hunt, formerly lieutenant-governor, Southern Provinces of Nigeria.

This Commission of Research held in all eight meetings, the first on January 2 and the final one on April 10. The verbal discussions were supplemented by valuable notes contributed by the members and others on the various aspects of the questions involved.

The final session was devoted to the adoption of a series of resolutions embodying the Commission's recommendations as to the measures necessary to deal with the problems discussed, these problems having been considered under five main heads as follows:

1. The native custom of shifting cultivation.
2. Bush fires, and the native custom of burning the bush.
3. Grazing.
4. Soil erosion, and reservation of forests.
5. Regeneration of poor or exhausted soils.

On each of these problems the Commission put forward its analysis of the position and its practical proposals for measures to cope with that position.

The proceedings and findings of this Research Commission are being circulated by the Royal African Society to the Governments mentioned and to the neighbouring and other Governments concerned with Africa, in the hope that agreed principles, both of doctrine and of practice, may be regarded as having emerged from the Commission's deliberations, and that this may lead to a new concerted effort to rid Africa, and other tropical countries, of a scourge which, unless dealt with, threatens the very habitability by mankind of large portions of the earth's surface.

E. N. CORBYN.

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Aug. 27.

Paracelsus and "Basil Valentine"

To honour the memory of Paracelsus, who died four hundred years ago, the Institute of the History of Medicine at the Johns Hopkins University has issued four of his treatises in English translation. In a review of this volume in NATURE (May 9, 1942, p. 510) the statement occurs that Paracelsus "borrowed much, without acknowledgement, from Basil Valentine". To many of us who have formed a definite picture of Paracelsus's character, plagiarism would seem to be the last fault of which he might be rightly accused, and as this imputation (which has been frequently made since the seventeenth century) nullifies to a certain extent the purpose of the memorial volume, it might be permitted to ask whether this slur upon the character of the great man is well founded.

More than fifty years after Paracelsus's death, treatises somewhat similar to his began to appear which purported to be based on the manuscripts of a nebulous personality called Basil Valentine, who was supposed to have lived in the fifteenth century. The tremendous reading of the famous German historiographer of chemistry, H. Kopp, has failed to detect in the richest libraries any trace of such manuscripts or any contemporary reference to the man, and nothing has come to light since. On the contrary, many of the arguments Kopp uttered tentatively to show that the treatises of the so-called Basil Valentine had been written after Paracelsus were strengthened and enlarged by recent studies; of special importance was the discovery, in 1925, by F. Fritz of a book forming clearly a link between Paracelsus and "Basil Valentine".

To assume that Paracelsus was in possession of copies of "Basil Valentine's" writings, that he (who so much despised literary tradition and based everything on his own personal experience and philosophy) used them secretly for gaining credit without a single one of his many embittered enemies discovering and exposing this fraud, and that these manuscripts then vanished completely with the exception of the copies which about 1600 were put into print and then disappeared too—that does not seem a plausible hypothesis. The boot is evidently on the other leg: those of "Basil Valentine's" works which show similarities with Paracelsus's ideas and discoveries were rather composed by a man living in the later part of the sixteenth (and not in the fifteenth) century, who was familiar with the writings of Paracelsus but anxious not to disclose his indebtedness to this inspiring reformer. The pretence of high antiquity, the only argument in favour of the alternative hypothesis, is so common in alchemistic literature that one can scarcely give it any weight in face of such strong evidence to the contrary.

We have no reason to doubt that throughout his life Paracelsus was faithful to the proud maxim he inscribed to two of his portraits: "*Alterius non sit qui suus esse potest.*"

F. A. PANETH.

University,
Durham.

I AM grateful to Prof. Paneth for pointing out a very misleading—if not entirely false—statement. The Paracelsus question is so obscure, and still so controversial, that it was only on re-reading Dr. Bayon's article in the *Proceedings of the Royal Society of Medicine* of November, 1941, that I realized how strongly the opinion of specialists has turned against the "Basil Valentine" hypothesis. It would have been better to have said: "Some have thought that Paracelsus borrowed . . ."; better still to have said nothing at all about Basil Valentine. For, in the days before universal printing and stringent copyright, to borrow was no sin. The habit was common, and did not seriously reflect upon the borrower's honesty, particularly in a work not specially intended for publication, unless originality was claimed or the amount borrowed extensive.

Furthermore, I was concerned, not with an involved and obscure point of literary controversy, but with the value of Paracelsus's doctrines. A little about these would have been more to the point than a reference to the "Valentine" controversy. I hold that Paracelsus did more for science and philosophy than is generally allowed; far more indeed than Dr. Bayon, for example, would put to his credit. It is true that his work was wild, erratic and mixed with fancy and superstition; in other words, he was not a strictly scientific man. This fault has brought upon him much scorn and criticism, some not altogether deserved. But with all his violence and crudities, he is rich in inspiring suggestions, and I am truly sorry if any word of mine has harmed the reputation of a thinker for whom I have a great and sincere admiration.

W. H. S. JONES.

FEEDBACK AMPLIFIERS

By C. A. A. WASS

THE use of negative feedback to give improved performance in a number of important respects is now a well-established feature of amplifier design technique, and the simple mathematical treatment of an amplifier with feedback has been given by a number of writers. The earliest of these accounts was in a paper by Black[1], who showed that if an amplifier has a voltage gain of μ times, and an attenuating network is connected between the output terminals and the input terminals in such a way that a voltage equal to a fraction β of the output voltage is connected in series with, and in opposite phase to, the input voltage, the amplifier gain will be reduced in the ratio $1/(1-\mu\beta)$; but at the same time the distortion voltages for a given fundamental output will be reduced in the same ratio.

Besides reducing the distortion, negative feedback reduces the rate of change of amplifier gain with changing supply voltages, reduces some kinds of noise which originate in the amplifier, and can be used to flatten, or otherwise modify, the frequency response. It also has the effect of changing the effective impedance at points where the β circuit is connected to the amplifier, and has been used in this way to reduce the impedance of a pentode output valve so as to give better loud-speaker damping, and also to increase the input impedance of valves in high-frequency amplifiers.

It is clear, then, that negative feedback has great attractions for amplifier designers, especially as the explanations often given suggest that the application of feedback is quite a straightforward matter. It is only necessary, apparently, to feed back a voltage from the output terminals via an attenuating network to the input terminals, making sure that this voltage is in the 'right phase' to give reduced gain, and all the benefits follow automatically. Unfortunately, attempts to do this often result in the amplifier becoming unstable, particularly if more than a very modest degree of feedback is aimed at or if the effective frequency range of the amplifier extends above a few kilocycles per second. To understand this trouble, and to determine whether or not it can be overcome, a more rigid mathematical treatment than that mentioned earlier is required.

The simple mathematical treatment as usually given assumes—often tacitly—that μ and β are simple numbers, implying that neither the amplifier nor the feedback network cause any change of phase of the signals they transmit. Actually, although this may be approximately true near the middle of the working frequency band, phase-shifts always occur at higher and lower frequencies because changing phase is inseparable from falling gain. If the phase characteristics as well as the gain and attenuation characteristics of the amplifier and feedback network are taken into account, a much more useful and comprehensive statement of the effects of feedback can be obtained. Black's paper deals also with this more complex version of the problem, but the results seem to have received comparatively slight attention.

To find the effects of phase-shift in the amplifier, it is convenient to regard the quantity μ as a vector, of which the modulus $|\mu|$ represents the voltage gain of the amplifier and the angle represents the phase shift through the amplifier. Similar considerations apply to β. A signal which passes once through the amplifier and then once through the feedback network suffers a change of magnitude $|\mu\beta|$ times, and the corresponding change of phase is ϕ, say. ϕ does not include the fixed 180° per valve, which can be disregarded for the present purpose. It will be seen that $\mu\beta = |\mu\beta| \cos \phi + j\,|\mu\beta| \sin \phi$, where $j^2 = -1$.

The gain of the amplifier is still changed in the ratio $1/(1 - \mu\beta)$ when feedback is applied, but the quantity $(1 - \mu\beta)$ is now to be regarded as a vector. If the modulus of $(1 - \mu\beta)$ is called R, it will be seen that $R = |1 - \mu\beta|$ which is equal to ratio of gains before and after feedback is applied, and it can be shown that $R^2 = 1 - 2\,|\mu\beta| \cos \phi + |\mu\beta|^2$. This equation represents a family of concentric circles of radii R and centre at the point $(1, \hat{0})$. To interpret this equation a diagram is prepared by drawing a number of circles with radii greater than, equal to, and less than unity, with a common centre at the point $(1, \hat{0})$, using polar co-ordinates.

This simple diagram can be used to predict the change of gain resulting from the application of any degree of feedback to any amplifier under a fixed set of conditions provided that $\mu\beta$ is known completely, that is, provided that both $|\mu\beta|$ and ϕ are known. A line of length $|\mu\beta|$ is drawn from the origin at an angle ϕ, and the position of the end of this line with respect to the family of circles indicates the change of gain due to feedback. Thus if the line ends on the circle of radius 5, it means that the gain will be reduced by five times; if the line ends on the circle of radius 0·25 it means that the gain will be made four times greater; if the line ends on the circle of unit radius the gain will be unaltered when feedback is applied. It will be seen at once that the unit-radius circle is of special importance as the boundary between regions of 'negative' feedback, which reduces the gain, and 'positive' feedback, which increases the gain, and of course the region of positive feedback is restricted to points within the circumference of the unit-radius circle. This represents a considerable modification of the usual statement that feedback is negative when ϕ is in the neighbourhood of 180° and positive when ϕ is small or zero. This statement, while being useful as a rough-and-ready guide, gives no indication of what happens when ϕ is, say, about 90° or 270°; moreover, although it is true that feedback is always negative when ϕ lies in the neighbourhood of 180°, or more accurately between 90° and 270°, feedback is not always positive when ϕ is zero. Thus if $\phi = 0$ and $|\mu\beta| > 2$, the line representing $\mu\beta$ will lie along the reference line and it will end at a point outside the unit-radius circle. From what has been said before, this will correspond to a reduction of gain, that is, the feedback will be negative. This is a somewhat surprising result, and if a physical interpretation is sought, it seems at first sight that in an amplifier in which these conditions obtain the voltage fed back from the output terminals through the β circuit to the input terminals is more than twice as large as, and exactly in phase with, the input voltage, so that the net input voltage to the amplifier is apparently more than three times as great as before feedback was applied; yet the amplifier gain is reduced. The true explanation is that the phase of the output voltage is changed by 180° when feedback is applied, so that the feedback voltage is in opposite phase to the input voltage. This case is, of course, of little practical importance because it is difficult to realize the required conditions of $|\mu\beta| > 2$ and $\phi = 0$ in a stable amplifier. It is of interest, however, because it prepares the way for a complete statement of the conditions for stability in an amplifier with feedback. This statement is embodied in Nyquist's criterion, which can be explained with the help of the circle diagram.

Suppose in the case of an amplifier working under constant conditions with a certain degree of feedback, the value of $\mu\beta$ is known over the whole range of frequencies from zero to infinity. Now if a series of lines representing $\mu\beta$ at various frequencies is drawn on the circle diagram and a smooth curve is drawn joining the ends of these lines, the curve will form a closed loop beginning and ending at the origin, since $\mu\beta = 0$ at zero and infinite frequencies (direct current amplifier amplifiers being excluded). Nyquist's criterion, which is based on theoretical considerations, says that if the point (1, 0) lies inside the loop the amplifier will be unstable; if the point lies outside the loop the amplifier will be stable. The loop may have a complicated shape, and could, for example, have a lobe crossing the $\phi = 0$ line at two points beyond (1, 0), and it is seen that the case discussed earlier in which $\phi = 0$ and $|\mu\beta| > 2$ is theoretically possible in a stable amplifier.

As a check on Nyquist's work, Peterson, Kreer and Ware[2] built an amplifier in which the $\mu\beta$ loop had a lobe of this kind, and it was found to be stable.

In practical amplifiers it is often unnecessary to plot a complete $\mu\beta$ loop, and indeed a single point can sometimes be very useful. Thus, if the frequency at which $\phi = 0$ can be found and the value of $|\mu\beta|$ at this frequency is measured or calculated, it can generally be assumed that the amplifier will be stable if $|\mu\beta| < 1$ and unstable if $|\mu\beta| > 1$, since lobes are unlikely to occur in straightforward amplifiers. If $|\mu\beta| > 1$ at $\phi = 0$ it is often possible, by examining the loop in this region, to find some way of reducing $|\mu\beta|$ without appreciably affecting the performance of the amplifier in the working band. It must be realized, however, that for a given frequency band the degree of feedback possible in a stable amplifier is a fixed finite quantity which cannot be exceeded no matter what number of complicated phase-correctors and other devices are used. The estimation of this quantity is dealt with in a paper by Bode[3] which gives a complete method, based primarily on Nyquist's criterion, for the theoretical design of a negative feedback amplifier.

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[1] Black, H. S., "Stabilised Feedback Amplifiers", *Bell System Tech. J.* (Jan., 1934).

[2] Peterson, Kreer and Ware, "Regeneration Theory and Experiment", *Bell System Tech. J.* (Oct., 1934).

[3] Bode, H. W., "Feedback Amplifier Design", *Bell System Tech. J.* (July, 1940).

CONICAL REFRACTION

By SIDNEY MELMORE

Yorkshire Museum

An interesting paper on this subject by R. Potter appeared in the year 1841[1]. He "chiefly worked with an eye-lens, or else for micrometer measures with a compound microscope" and his conclusions (which are easily verified) are contained in the following passages: "The luminous ring is seen, and seen perfectly only, when the lens is so placed in its distance from the crystal, that what he [Lloyd] calls the two rays, are, in fact, the two virtual images of the luminous point on the first surface. The position of these virtual images within the crystal is found by the formulæ of geometrical optics, their distance from the second surface, when the incidence is nearly perpendicular, being equal to $\frac{\text{thickness of the plate}}{\text{refractive index}}$."

"Whether we draw the eye-lens away from the crystal, or push it nearer, we find similar appearances, and we see that the ring was formed by the intersection of two cones (or more correctly of two series of cones), the one converging so as to have the bright spot, we formerly found on the second surface, for its vertex, and the other diverging, and having the ring, formerly found on the second surface, for its base."

From these quotations it is evident that Potter was well aware of the possibility of extending the Duc de Chaulnes's method to the study of anisotropic media; but he gives no practical details, and the full development of this method is due to Sorby[2].

There is no reference to conical refraction in Sorby's papers; but they contain a description and figure of an effect directly due to it, which he left without investigation as a "curious appearance".

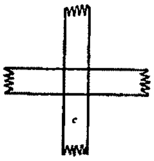

Fig. 1.

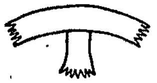

Fig. 2.

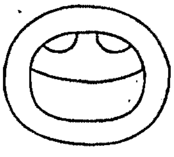

Fig. 3.

I observed the effects described below when using a plate of aragonite 8·1 mm. thick (cut approximately perpendicular to an optic axis) standing over a pinhole 0·09 mm. in diameter made in a piece of tin foil and viewed under a microscope provided with a 1-in. objective. When the crystal is set so that the refracted rays travel along the acute bisectrix, a cross is seen (Fig. 1); and when viewed through an analyser, first one bar and then the other is extinguished as the analyser is rotated, and the extinction takes place simultaneously at every point in the bar. On tilting the crystal about an axis perpendicular to the optic axial plane, one of the bars gradually becomes curved (Fig. 2). When the tilt amounts to about 6½° from the acute bisectrix it is apparent that the curved bar is no longer extinguished simultaneously at all its parts, and on closer examination it is seen that the extinguished part of the curve moves through double the angle that the analyser is rotated. By tilting about 8½° from the bisectrix, the appearance figured by Sorby is seen (Fig. 3). The ring is due to the hollow cone of rays diverging from a focal point considerably out of focus, and the centre of the figure represents the other focal point nearly in focus. The light of each cone is polarized according to the Hamilton-Lloyd law. By altering the focus, the figure changes into an elliptical ring. About 16½° from the acute bisectrix (that is, in the region of the optic axis), the cones from the two focal points intersect and form a ring approximately circular. In this position the two images of the pinhole lie one above and the other at a nearly equadistance below the plane of the ring and in a line nearly perpendicular to it.

No great accuracy is claimed for the angular measurements given above, but they are sufficient to show that the two features characteristic of conical refraction, namely, a curved wave-front and a particular state of polarization, appear soon after the acute bisectrix is passed and become progressively more complete and intense as we approach an optic axis. The Fresnel wave-surface accounts for a sudden change from point contact to circular contact of a tangent plane, but some modification of it seems necessary to account for a progressive change: what form this modification should take it is difficult to see.

After considering the subject of conical refraction, Stokes concluded: "We see, therefore, that the limitation of the number of tangent planes to the wave-surface, which can be drawn in a given direction on one side of the centre, to two, or at the most three, is intimately bound up with the number of dimensions of space; so that the existence of the phenomenon of internal conical refraction is no proof of the truth of the particular form of wave-surface assigned by Fresnel rather than that to which some other theory would conduct[3]."

Clifford hoped that useful results would flow from the application of the elliptic geometry of space: "I am", he wrote in 1870, "endeavouring in a general way to explain the laws of double refraction on this hypothesis, but have not yet arrived at any results sufficiently decisive to be communicated[4]."

No results are to be found among his published papers.

There is a rather obscure passage in Potter's paper suggesting the existence of a real focus outside the crystal, but it is doubtful whether this represents a record of observation or an inference from theory. Sir C. V. Raman has, however, recently obtained conclusive proof of its existence, and he finds that "the usual explanations of conical refraction do not go deep enough into the physical aspects of the problem"[5].

Hamilton himself wrote to Lloyd on January 1, 1833: "It is much for theory to have predicted the *facts* of conical refraction, but I suspect that the *exact* laws of it depend on things as yet unknown"[6].

[1] Potter, R., *Phil. Mag.*, **18**, 343 (1841).

[2] Sorby, H. C., *Min. Mag.*, **1**, 193, Pl. vii, Fig. 10 (1877); *ibid.*, **15**, 189, Fig. 7 (1910).

[3] Stokes, G. G., *Rept. Brit. Assoc. for 1862*, 253 (1863).

[4] Clifford, W. K., *Proc. Camb. Phil. Soc.*, **2**, 157 (1876); reprinted in "Mathematical Papers", 21 (1882).

[5] Raman, C. V., and Nedungadi, T. M. K., NATURE, **149**, 553 (1942).

[6] Graves, R. P., "Life of Sir William Rowan Hamilton", vol. 1, 630 (1882).

CENTRAL SCIENTIFIC AND TECHNICAL BOARD

A MEETING was called by the Association of Scientific Workers on September 4 to discuss and support the proposals for a Central Scientific and Technical Board. These proposals had been the subject of a Motion on the Order Papers of the House of Commons for which, according to *The Times* of September 9, 126 signatures of members of Parliament had been obtained.

The papers and discussion at the meeting showed that more scientific workers and engineers consider that there is a real need for a Central Board to link science to the central direction of the War, and two main reasons were given. The first was that our scientific resources are not being used as efficiently as they should be. The question of duplication of work and the problem of those who consider that their work is not of immediate importance to the war effort, as well as the lack of consultation of technical staffs on technical questions affecting production, were all mentioned in this section. The second main contention was that as scientific and technical considerations permeate every sphere with which the War Cabinet must be concerned; that, as in fact science affects strategy and strategy must determine scientific development, it is essential that technical advice shall be immediately available to the War Cabinet.

Mr. A. L. Bacharach, in the chair, referred to the responsibilities facing the Association, not only to gain better conditions for scientific workers but also to improve the role of science in the community. Although the Association is a trade union, by virtue of the peculiar position enjoyed by science the Association has a moral obligation towards society, and cannot separate the status of scientific workers from the status of science.

Lord Strabolgi said that many of the present difficulties facing the United Nations are directly traceable to the fact that we have not yet begun to use fully the scientific man-power of the nation. In modern war, machinery and equipment have a tremendous importance and without them the bravest men are helpless. It is not a question of insufficient funds having been at the disposal of the Service Department but rather the question of the proper use of funds. He considers that only the Air Ministry has taken full advantage of science; not only has it got its own scientific departments but it has also drawn most freely on outside men of science. He paid a tribute to the rapidity with which the Admiralty has found remedies for new devices sprung upon us by the enemy, but holds nevertheless that the Admiralty suffers through being a closed department and not taking advantage of outside developments. We have greater scientific knowledge and experience in Great Britain than in the whole of the Axis Powers: it is only waiting to be used.

Mr. Swann, referring to the investigations made by the Association into conditions in industry and Government service, said these showed conclusively that in a number of important respects the scientific and technical resources of the country were not being used to the full in the war effort. In its proposals for improving the position the Association has received support from many other bodies and a number of detailed improvements have been made during the last six months. These have, however, not by any means fulfilled the stated need for better organization of scientific and technical workers.

Technology is concerned with the processes of manufacture and their improvement and is an essential factor in production itself. New developments are the constant concern of the research and development establishments under the Supply Ministries, in industry and the universities, and these developments need to be closely linked with production. Science is also concerned with the equipment when it is made, how it works in practice and what modifications are necessary. Science is also concerned with the community, its food, its health, its protection from air attack, etc. All these functions of science and technology are divided up in the various Government departments and industry; yet all these functions are related, and all are affected by the main strategy of the War. Strategical considerations determine which scientific problems are the most important; and conversely, the strategy of the War may be changed by scientific developments.

There is a great need for a body of scientific men who can indicate what assistance science can give to the development of strategy, who can interpret in technical terms the requirements of the strategy decided upon, and who can co-ordinate the scientific and technical work in the various Government departments and in industry. Such a body would need to be a full-time body, in direct contact with the War Cabinet, and with powers to obtain all necessary information on the resources and problems in the scientific and technical field; with the authority to initiate programmes of work and to have direct access to working scientists and engineers. The Association's proposals for a Central Scientific and Technical Board included these functions and powers. Mr. Swann pointed out that while many non-technical people spoke of men of science as 'inventors' the problem of the individual inventor is a special one, and is already very well provided for. Only a small proportion of the scientific discoveries made in this or any other country are due to individuals working on their own; the majority of discoveries are made by teams of workers in research and development establishments, either in Government service or in industry. It is these people who provide the bulk of scientific workers in Great Britain and with whom we are concerned in discussions of planning.

Other speakers from the platform and those who joined in the discussion from the floor all contributed arguments demonstrating the need for central planning in their own fields of work. Mr. D. T. Waigh spoke for men of science in industry, who, he claimed, represent the great majority of our scientific man-power. The scientific and technical staff have a fund of initiative and use it wherever they can; but they are often frustrated in their efforts through the existence of overlapping, lack of consultation and the feeling that their work is not co-ordinated into an effective whole.

Dr. D. McClean spoke of the need for planning in the biological sciences. He mentioned the absurd and damaging distinction between academic institutes and commercial undertakings, many of which are doing first-rate research and are at present the only organizations capable of translating laboratory processes into large-scale production. Bodies such as the Medical Research Council and the Agricultural Research Council are doing excellent work in their own institutes and by subsidizing research as well; but have never accepted responsibility for directing the national effort in the medical, veterinary and agricultural fields.

Mr. Innes spoke of the difficulties encountered by operational research groups, which are in general doing such good work. He considers that there is a need for combination between the different branches of the Services to avoid overlapping and waste of energy. The groups do not get sufficient guidance as to what is required, and for the efficient prosecution of their work they need knowledge of the research and production development that is actually being carried out on military equipment. Any central body must have its roots in working scientists and there must be close liaison with the scientists working for the Forces. To the working scientist it appears that there is not sufficient policy decision on how our scientific man-power should be used.

The day after the meeting reported above it was announced that three full-time scientific advisers had been appointed to the staff of the Ministry of Production (see Nature of September 12, p. 301). While the Association welcomes these appointments as a step to link science with production, it is certainly not clear from the official announcement whether the scope of activities of the three advisers will be wide enough to answer the demand for a Central Scientific and Technical Board. Questions which are bound to be asked are: what powers the advisers will have to get information and to put their recommendations into practice, whether it will be possible to extend their work to include the scientific and technical activities of the Service Departments and other Ministries outside the strict field of production, what the position of the Lord Privy Seal will be in supervising the work of these advisers, and their relationship with the War Cabinet and the Minister of Production. Until these and other questions are answered in practice, those who have supported the call for a Central Scientific and Technical Board will no doubt continue to voice their demands for something wider than the appointment of advisers to a single Minister.

FORTHCOMING EVENTS

Saturday, September 26

Society of Chemical Industry (Joint Meeting of the Manchester Section and the Food Group) (in the Reynolds Hall, College of Technology, Manchester), at 2.30 p.m.—Dr. L. H. Lampitt: "The Preservation of Foodstuffs".

Monday, September 28

Society of Chemical Industry (Yorkshire Section) (in the Chemistry Lecture Theatre, The University, Leeds), at 6 p.m.—Dr. E. C. W. Smith: "Incendiary Materials".

Thursday, October 1

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. C. L. Fortescue: Presidential Address.

Saturday, October 3

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. David Williams: "Mineral Resources of the U.S.S.R.".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer in Chemistry—The Registrar, The University, Manchester 13 (September 30).

Principal Teacher of Engineering (Mechanical and Electrical) in the Technical College, Coatbridge—The Director of Education and Deputy County Clerk, Lanarkshire House, 191 Ingram Street, Glasgow, C.1 (October 2).

Teacher of Electrical Engineering—The Principal, Wolverton Technical College, Wolverton, Bucks. (October 3).

Assistant Lecturer in Mechanical Engineering—The Registrar, College of Technology, Manchester 1 (October 5).

Lecturer in Mechanical or Electrical Engineering in the Cannock Chase Mining College—The Director (H), County Education Offices, Stafford (October 14).

Assistant Master to teach Machine Shop Practice, Theoretical and Practical—The Principal for Further Education in Gillingham, Medway Technical College, Senior Departments, Gillingham.

Lecturer (man or woman) in Mathematics for the Junior Technical School for Boys—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

Steward for Organic Chemistry Department—The Laboratory Superintendent, Chemistry Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.

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WAR-TIME USES OF ANTHROPOLOGICAL SURVEYS

DARWINISM affected the study of the racial classification of man in various ways. It offered a plausible hypothesis to account for the diversity observed within the species, and anthropologists soon realized that new descriptive data would be needed to test the theory at all effectively. The systematic collection of records of the physical characters of samples representing different populations began about 1860. Techniques were laid down defining measurements and observations to be taken on series of living people and skeletons. The characters used earlier were principally certain measurements of the head and body, and records of skin, hair and eye colours. The list was supplemented by blood groups after the War of 1914–18. The advantages of a statistical treatment of both the quantitative and qualitative data are now generally appreciated.

Owing to the lack of any effective international agreement regarding matters of technique and planning, the anthropological records are far less useful than they might have been made with the same expenditure of labour. Nevertheless, they form a substantial bulk of reliable evidence, though ways in which it should be treated and interpreted for taxonomic purposes are still highly controversial. In the past eighty years, anthropological surveys of living populations have been carried out on larger or smaller scales in most parts of the world. The evidence is distributed in a very uneven way, some regions being well described while others are badly documented. In Europe nearly all the investigations have been of a national kind, the two most comprehensive being for Sweden and Norway. Shortly before the present War, Harvard University sent an anthropological expedition to carry out a survey of the people of Ireland, which was almost an untrodden field. The results have not been published yet. England is among the European countries the populations of which are least well known from the same point of view.

It has repeatedly been urged that surveys of the physical characters of national populations should be carried out for other purposes. Most of these come within the scope of 'race biology'. Official demographic and medical statistics give some indication of the biological condition of a people, but they leave many questions unanswered. The announcement that the British Army Medical Service had great difficulty in obtaining a large enough number of men of adequate physique for service in the South African War was a revelation. Much discussion of national degeneration followed, but there was little scientific evidence bearing on the topic. The report published in 1920 on data for recruits collected two years earlier again disclosed a disquieting situation. About the same time special inquiries of limited scope were undertaken which revealed the prevalence of malnutrition and some of its effects on physique.

There is still an urgent need for a survey which will assess the physical fitness and capabilities of the population of Great Britain. Physiological and medical tests and observations are the data principally required in this connexion, but the customary anthropological characters should be recorded as well, since it is necessary to make allowances for racial diversity in interpreting the import of regional and class differences. It is significant that the first major task undertaken by the Swedish State Institute for Race Biology was a purely anthropological survey of 47,000 conscripts from all parts of the country. Knowledge of that kind is of basic importance in many connexions.

The medical information gained from the examination of recruits is of immediate military importance. So also have been the few body measurements usually recorded at the same time. They have been used principally to determine limits of height and weight taken into account when deciding whether men should be rejected or assigned to a particular grade. All fighting services have fixed minimum statures for entrants to different forces. Measurements of recruits collected in several European countries in the past century revealed the fact that there has been a secular increase in the average statures of many populations. Hence it was necessary to change the standards adopted from time to time.

In some countries body measurements have doubtless been used extensively for other military purposes to which there is scarcely any reference in the literature of anthropology or any other science. They should obviously be of assistance in connexion with the supply of clothing and equipment. There are two kinds of problems encountered here. The first is concerned with the provision of things worn by the men. In the case of clothes of ordinary kinds, the ranges of shapes and sizes needed, and the relative frequencies with which they are required, are known to the manufacturers on account of their extensive experience. In the case of articles designed for special purposes, however—such as helmets worn by airmen, or equipment carried by infantrymen—there may be no such guidance. A trial-and-error method of gaining the experience required is likely to be slow and wasteful. Measurements already recorded for anthropological purposes would probably be found to aid particular specifications to greater or lesser extents. If they are not sufficient, it should be profitable to take new measurements on a suitably chosen sample of a few hundred men. In cases where accurate fitting is a matter of considerable importance, a special investigation might be needed to discover whether the manufacture of standard sizes can give satisfactory results, or whether the article should be made to measure.

The second kind of supply problem referred to concerns the allocation of men to confined spaces of particular dimensions, such as the compartments of aeroplanes, tanks and submarines. Ideally, it may be considered most expedient to take body measurements into account when designing such conveyances. If they have been made with no detailed regard to that factor, then it is still desirable that body measurements should be used in deciding which men should be assigned to particular duties, so that their accommodation, and the efforts they make in reaching controls, cause no avoidable discomfort or strain. Metrical data available could certainly be used with advantage in this connexion, but additional records might be needed to give entirely satisfactory results.

It may be suggested that there can be little practical advantage in discussing these matters now, since nothing approaching a comprehensive anthropometric survey of the population of Great Britain, or any large section of it, has ever been undertaken. Neglect of such research can be attributed partly to good fortune in being almost free from racial disputes and animosities within Great Britain, and partly to the fact that only small fighting forces were maintained in peace-time. A committee of the Ministry of National Service published a report on part of the evidence collected by the medical boards during the War of 1914–18. Data were included for three measurements—height, weight and "chest expansion"—but the way in which they are presented is statistically inadequate. Officialdom has cared little for these things.

In June 1939 a committee of the Royal Anthropological Institute was set up for the purpose of urging the authorities to take advantage of the opportunity offered of collecting scientific evidence in connexion with the medical examination of recruits called up under the Military Training Act. Its principal concern was in advocating that a few body measurements and observations should be taken on some 30,000 men, to obtain an adequate knowledge of the racial constitution of the population of England, Scotland and Wales. Repetition of the measurements was urged, so that the effect of training and standardized diet on physique could be estimated. At the same time, efforts were made to interest certain other bodies which might have collaborated in the inquiry and extended its scope by adding tests and observations of physiological and genetical significance. The outbreak of the War led to the suspension of negotiations which had encouraged the hope that the scheme would receive official backing. Attempts to revive it later were unsuccessful, although the information which might have been obtained by such means was needed more urgently once hostilities had started.

In some respects nothing can compensate for the absence of an anthropological survey. If it is lacking the diversity within a population due to differences in the origins of its component sections is unknown, and the extent to which any regional or class differences should be attributed to the racial factor must remain a matter of surmise. In spite of these limitations, it is possible to apply some of the data obtained from the survey of one country to the population of another country, to give the kind of information required in connexion with supply problems. For example, the body (excluding the head) measurements of the populations of Western Europe indicate distinctions in size rather than shape. So far as is known, the relative proportions of the limbs and trunk, or segments of them, are remarkably constant for these populations, and a close approach to equality is also found in variation and correlation. If data for stature, but for no other character, are available for a particular one of the countries, then it is possible to predict a great deal of information regarding other characters of its members by applying results derived from the surveys of other countries. This is a statistical matter, and the scope and accuracy of the predictions referred to could be investigated adequately by treating extensive material available in the anthropological literature.

The population of the British Isles has remained unsurveyed by anthropologists, though records of the statures, at least, of large numbers of men of military age must have been determined in recent years. It is fortunate that extensive anthropometric surveys have been carried out for two allied populations, namely, the Swedish and Norwegian. In fact, these two have been better described in the respect considered than any others in the world. With proper reservations, the results for them could be applied to men from the British Isles to give information required for military purposes. There are several other ways in which knowledge and experience gained by physical anthropologists might be applied immediately to certain military problems in the interests of economy and efficiency. It may not be proper to ask what has been done already in this direction, but there can be no impropriety in suggesting that this is a matter which should be given careful consideration by those responsible for the Government's policy on the use of scientific and technical resources.

The need seems to be for an advisory committee which could deal with all questions of the kind referred to. Such a body should include anthropologists with knowledge of the relevant literature and experience of techniques used in measuring human beings, and statisticians who would ensure that the data were used in the best way. One of their first tasks might be the reduction of body measurements already taken of men serving in the Fighting Forces. Information derived from them should be presented in a concise and convenient form to those requiring it who are concerned with production and the assignment of men to particular duties. The value of published anthropometric records for the same purposes could also be considered, and the committee might seek permission to use the data collected in certain unpublished surveys of sections of the British population which have been carried out for academic purposes. It could be called on to deal with any new problems falling within its scope, and should be given power to undertake new investigations involving the measuring of samples of the populations concerned. The primary aim would be the speedy solution of problems connected with immediate war-time needs; but it is not to be doubted that the information and experience gained would later be found to be of scientific value in elucidating certain problems of medicine and race biology which are also of great importance to the State.

WORLD CO-OPERATION IN PRODUCTION, CONSUMPTION AND DISTRIBUTION

SIR STAFFORD CRIPPS'S address on July 25 at the Conference on Mineral Resources arranged by the Division for the Social and International Relations of Science of the British Association was noteworthy as an indication that the Government is willing and eager to meet the challenge of a remarkable series of speeches recently made by leading American statesmen. The views expressed by Mr. Wallace, Mr. Milo Perkins and Mr. Sumner Welles in May, by Mr. Winant at Durham in June, and by Mr. Claud Wickard, Mr. Dean Acheson and Mr. Appleby in July, all of whom are intimately concerned with the formulation of American policy, may be taken to represent official thought in the United States on the problems of post-war reconstruction. Sir Stafford Cripps, in welcoming these beginnings of an interpretation of the generalities of the Atlantic Charter, was clearly speaking for the Government, and in promising "willing co-operation along the paths which they indicate", he carried a stage further the promise made earlier in the same week by Mr. Eden and Sir William Jowitt.

The keen interest in these pronouncements betokens the general sympathy in Great Britain with the American agreement and the desire that British leaders should take their full share in formulating future policy on these lines. In Great Britain as in the United States, war is seen as part of a continuous process the roots of which lie deep in poverty, insecurity, starvation and unemployment, and this War will not be really won until the deep causes of war have been uprooted. As Mr. Winant says, this is no short-term military job: "To crush fascism at its roots we must crush depression democracy. We must solemnly resolve that in our future order we will not tolerate the economic evils which breed poverty and war. This . . . is part of the war. . . ."

This new thesis, this deeper view of social and international responsibility, which goes down to the foundations of society in seeking to discover the causes of such manifestations of social disease as totalitarian war, is quite incompatible with isolationism, which it would eliminate, not only on the grounds of world solidarity and comradeship but also of plain self interest. It involves a moral revolution which Sir Stafford Cripps did well to emphasize. Warmly as these views are welcomed, it would be a disaster if there were any failure to understand the sacrifices and changes which will be demanded if the principles of the Atlantic Charter are to become more than pious aspirations. The reports of the Chambers of Commerce, the National Union of Manufacturers and the Federation of British Industries, all issued in the same period, are both measure and warning of the opposition, the prejudices and the difficulties which have to be overcome.

It is, of course, only in broad outlines that the solution is sketched in the speeches made by the American statesmen. Mr. Wallace, referring to

America's opportunity, suggests that the century on which we are entering will be known as the century of the common man. It may be America's opportunity to suggest the freedoms and duties by which the common man must live; and modern science, when devoted wholeheartedly to the general welfare, has in it potentialities of which we do not yet dream. But the will to peace and the continued co-operation of the United States and Britain form the political framework. No nation will have the God-given right to exploit other nations. Older nations will have the privilege of helping younger nations to start on the path to industrialization, but there must be neither military nor economic imperialism, and modern science must be released from German slavery. There can be no privileged peoples, and there will be the supreme duty for the citizen of sacrificing the lesser interest for the greater interest of the general welfare. Moreover, as Mr. Cordell Hull puts it, we must no longer ignore the simple but fundamental fact that the price of peace and of the preservation of right and freedom among the nations is the acceptance of international responsibility.

Mr. Welles, in his address, suggested broadly a long armistice, the disarmament of the aggressors, a United Nations police force, and finally the United Nations as the nucleus of a world organization to determine the final terms of a just, an honest and a durable peace as successive stages. This approach to political and military security springs from that new conception of the deep causes of war and of the new and dynamic conception of post-war relations which finds such vivid expression in Mr. Winant's great speech at Durham. The scientific and economic resources which produce the weapons of war can produce in as great a measure the instruments of peace.

"We have enough technical knowledge and organizing ability to respond to this awakening of social conscience. . . . When war is done the drive for tanks must become a drive for houses. The drive for food to prevent the enemy from starving us must become a drive for food to satisfy the needs of all people in all countries. The drive for physical fitness in the Forces must become a drive for bringing death and sickness rates in the whole population down to the lowest possible level. The drive for man-power in war must become a drive for employment to make freedom from want a living reality. The drive for an all-out war effort by the United Nations must become a drive for an all-out peace effort based on the same co-operation and willingness to sacrifice."

It is not beyond our technical or spiritual capacity, Mr. Winant continued, to have these basic things, and his speech gives noble expression to the expansive, purposeful concept of economics which underlies the new American outlook, the philosophy of what Mr. Sumner Welles calls "the frontier of human welfare". The key is expanding markets, a "mass consumption great enough to use mass production", "a future planned in terms of increase and not curtailment". Within the broad framework, private enterprise and free trade—the progressive sealing down of trade barriers and the end of all discriminating measures—are to be the chief instruments of economic advance, though some measure of Government control is envisaged, and Mr. Milo Perkins speaks of "a bold and daring use of long-term credits by Governments entering fields where private finance cannot enter without taking risks that are too great to take with other people's money".

There can be no doubt as to the revolutionary character of the policy advanced in these speeches. They represent a new conception of world order and an inspiring attempt to reinterpret democracy in terms of the twentieth-century situation and to extend its meaning in the economic and social sphere much as Lord Elton has done in "St. George or the Dragon". But it must be recognized that while this call for a co-operative venture, broadly based on the idea of the United Nations, comes from the progressive elements in the United States, there are powerful interests as well as many individuals who do not accept the thesis of co-operation.

For this reason the speeches of Sir Stafford Cripps, Mr. Eden and Sir William Jowitt were specially welcome. Sir Stafford Cripps rightly emphasized the moral revolution which is required if the principles of the Atlantic Charter are to become more than mere platitudes. Behind our scientifically prepared plans there must be, he urged, the inspiration of our deepest religious convictions. That will carry us along the road on which our feet have already been set in developing the plans of the United Nations for their war effort—the subordination of private and national interests to the public and international good.

The determined change of outlook from that of competition to that of co-operation will be as imperative after the War as for its prosecution, and without that outlook we may fail once again to carry over into the work of building the peace the organization for pooling material and experience developed for winning the War. Much of that may well serve eventually as the foundation of a permanent system of international management, and this series of speeches in Great Britain and in the United States of America should be welcomed first for its contribution to the education of public opinion to the sacrifices in private and sectional and national interests which will be involved. Neither Mr. Eden nor Sir Stafford Cripps failed to indicate the extent to which it is in the hands of the people of both countries how far this great experiment of Anglo-American co-operation can be continued after the War, and the necessity for a moral basis.

In associating himself with the hopes inspired by the American speeches, Mr. Eden pointed out that the solution of this problem of organizing full production and equitable distribution of what is produced would demand not only hard work and goodwill but also political invention of a very high order. The new problems cannot be solved along the old lines. In view of the caution and conservation of some of the industrial reports, it is all the more encouraging that Lord Simon, speaking in the House of Lords, should declare that we do not intend to be bound by the orthodoxies of the nineteenth century, and he emphasized that passage in President Roosevelt's report to Congress on June 11 on Lend-Lease operations in which the President asserted that the financial costs of the War can and should be met in a way which will serve the needs of lasting peace and mutual economic well-being; he also declared the Government's full agreement with the statement and its conviction that it provides a firm and solid basis for co-operation with the United States in winning the peace. The principles of expanding consumption and rising standards of living are also discussed by Mr. Walter Elliot in a recent thoughtful article in which he elaborates the theme of making them the foundations of an ordered and prosperous international community after the War, starting from the point made by Mr. Milo Perkins that our civilization is commodity-rich and consumption-poor. The interest aroused by the British Association Conference on mineral resources and the Atlantic Charter shows how public opinion in Great Britain is becoming aware of what is involved, and is prepared to support that survey of needs which must follow the research into the extent of world resources, of the methods of making them available and of placing them at the disposal of those who need them.

All this is required as a basis for action, and beyond this question of production there lie the even more baffling problems of distribution and consumption. The recent speech of Mr. Nash, Finance Minister of New Zealand, who had early suggested the creation of a World Reconstruction and Development Council through which a positive programme could be mapped out for carrying on a world of peace, contained a friendly warning which we do well to heed. He referred to our failure to give full weight to post-war reconstruction and development, which is the major aim of a large and influential section of the American people. Moreover, his concern that the whole management of the national war effort is being seriously handicapped by excessive reluctance to interfere with existing channels of production and trade applies equally to reconstruction.

The discussion on economic reconstruction after the War, opened by Mr. R. G. Glenday before the Royal Statistical Society on March 17, which has now been reported in the *Journal* of that Society, makes a timely appearance as a corrective to facile optimism which might be engendered by these pronouncements. Mr. Glenday insisted that changes in the business environment must be scientifically analysed and understood before any useful work could be done in planning for post-war reconstruction. He suggested that a factual examination of the condition of Britain's economic environment during the two pre-war decades would show that the change from Free Trade to Protection in 1931 was largely forced upon us by influences outside the individual control of governments. The major factors in precipitating this economic revolution, of which the present War should be regarded as part are, in Mr. Glenday's judgment, the closing of the age of territorial expansion, and the slowing down in the rate of population growth in the more developed and wealthier countries, coupled with continuing expansion in the less mature; and the failure to appreciate that, even though an economic system may not be consciously planned, it must in its process of growth conform to certain rules of order and structure if it is to avoid breakdown. In particular, the rates of growth of its separate parts must be kept in proper relation to one another, and for every structure there will be a most convenient size.

Mr. Glenday was clearly somewhat pessimistic as to the ability of industry to continue automatically to provide expanding avenues of employment, but while he pointed out correctly that the problem is that of creating new avenues of employment fast enough to absorb those thrown out of work by technological developments of a labour-saving kind, he appeared, as Prof. A. C. B. Fisher observed, to accept as axiomatic without further question that the obstacles he indicated were irremediable. Mr. Glenday did indeed suggest that the new comradeship of effort brought into being by the War may be the only solid foundation that we shall possess on which to build that new world for which so many are yearning, but his reference to the Atlantic Charter was scarcely constructive. Both Sir William Beveridge and Mr. Stanley Jevons joined issue with Mr. Glenday on these points, as indeed did Sir Gwilyn Gibbon, in whose brief appeal for concrete proposals rather than generalities lie the untold possibilities of further scientific advances. Sir William Beveridge, speaking from the chair, insisted that it is in our power to abolish want and to cure the evil of urban congestion, provided that we win the War and make such a reasonable contribution towards winning it; that the rest of the world would be friendly; that the nation wills these changes sufficiently to override the various vested interests; and that the changes are adequately planned. The transition problems would undoubtedly be harder to deal with at the end of this War, and Sir William urged that we should pay at least as much attention to problems of which the solution is within our power as to those of which the solution requires an international agreement.

There should be a generous response to the wider understanding, the quickened sense of human sympathy, and recognition of the common purpose of humanity which finds expression in both British and American speeches, and men of science will be able, by virtue of their training and outlook, to bring careful scrutiny to bear on the concrete proposals which may be formulated. But if scientific men, who have been brought up in an atmosphere of international co-operative development, can, as Sir Stafford Cripps pointed out, do much by their example and advice to create this new and challenging spirit among the free peoples of the world, there is one contribution they are supremely competent to make. From none better than from those who have devoted themselves to science, to the search for truth, can the free peoples acquire the habit of facing change fearlessly and bringing to the solution of our great problems of production, consumption and distribution that same adventurous spirit and willingness to accept new ideas and new ways by which science has won its triumphs.

FACTORY INSPECTORS AND THEIR WORK

Factory Inspection in Great Britain
By Dr. T. K. Djang. (London School of Economics and Political Science: Studies in Political Science and Sociology, No. 2.) Pp. 256. (London: George Allen and Unwin, Ltd., 1942.) 12*s.* 6*d.* net.

WHEREAS the work of the factory inspectorate in Great Britain has been very little affected by the transfer of the Factory Department in June 1940 from the control of the Home Office to that of the Ministry of Labour and National Service, the transfer indicates the great importance of factory inspection at the present time, and this first full-length study of the system to be published in this country is opportune. Dr. Djang's book traces the history of the inspectorate, describes its organization and explains the functions and methods of the inspectors. Moreover, the book is admirably annotated and is of real value, not only for an understanding of the work of factory inspection from the point of view of the general citizen, but also as a guide to many of the regulations under the Factory and Workshops Act and to the functions of the inspectorate for those who, in war-time, have been brought into closer contact with them. The bibliography is comprehensive and well arranged, though it might well have included more explicit reference to the excellent review of the work of the inspectorate during 1833–1932, which appeared in the annual report of the Chief Inspector for the year 1932. In the main, Dr. Djang's book is descriptive rather than critical, but the picture he gives leaves no one in doubt that the success of the factory inspectorate in Great Britain has been due largely to the inspectors themselves and to the extent to which they have succeeded in securing the co-operation of both employers and employees. There could scarcely be a better illustration of the value of the principle that in legislation the channels of assent should be dug deep.

It is a tribute to the wise use the inspectors have made of the great powers they possess that they succeeded in establishing so speedily their position as rather that of expert advisers than mere vigilance officers. One of the most interesting aspects of the factory inspection service is, indeed, the example it affords of the application of expert advice on matters of industrial and indeed public welfare. For this reason alone, Dr. Djang's book should be of wide interest to scientific workers, and not the less for the illustration it gives of the value of the system in educating both factory workers and the general public. The wise use of publicity made by the Factory Department, to which Dr. Djang directs particular attention, is only now becoming fully recognized, as indeed is indicated in the recent movement for the establishment of production committees and other methods of promoting industrial morale.

A further factor in the success of the system on which Dr. Djang lays some stress is the utilization of outside expert assistance. The Factory Department has worked in close collaboration with the National Institute of Industrial Psychology, the National Safety First Association, the Industrial Welfare Society, the Home Office Industrial Museum and the Industrial Health Research Board, of which only the last two are Government establishments. The work of the Department is probably weakest on the research side, and several recent reports have commented on the unsatisfactory state of research in the field of industrial health, notably those of the Select Committee on National Expenditure and of the British Medical Association's Committee on Industrial Health in Factories. Dr. Djang suggests that, to avoid overlapping, all research work on factory health and welfare should be entrusted to the Industrial Health Research Board, except that which the Factory Department considers could be conducted by the factory inspectors with greater convenience and better results. As to the need for greatly extending the vigour and resources with which such work is prosecuted, Dr. Djang's book leaves no room for doubt, and the Industrial Health Research Board should clearly be used as the Select Committee recommends and endowed with adequate resources. When all allowance has been made for the research in this field which the work of the Factory Department has already stimulated on the part of private firms, the value of such a central research organization cannot be questioned. Moreover, Dr. Djang's book emphasizes once more the extent to which the real problem of safety and health in industry is centred in the small firms where the management possesses neither the technical knowledge nor resources to cope with the problems unaided and unguided.

The suggestions which Dr. Djang himself advances for the improvement of the service are somewhat unequal. Of those affecting the reorganization of the Factory Department itself, those for investing the Chief Inspector with wider powers inside the Home Office than he at present wields, and in regard to the provision of an effective central information service, are the most convincing. Dr. Djang does not indeed mention some of the prime needs which the latter department might serve. The collection and systematization of information on accidents and matters affecting industrial health and safety are far from satisfactory, and the field is still very imperfectly covered, even from published literature, by existing periodicals. A central information department such as he suggests, which could surely count on all sources of official and unofficial as well as published information, should make a very real contribution to the important field of industrial health and accident prevention. There is nothing on the chemical side corresponding with the "Index Medicus", and the utility of the latter is very seriously impaired by the indifference to such matters as chemical nomenclature of medical men and their periodicals.

Dr. Djang also suggests the encouragement of foreign travel by the inspectors and the transfer of medical examination of young persons for factory employment to school medical officers, with regard to which it should be noted that an important section of medical opinion considers that the duties of the school medical officers can now largely be transferred to the general practitioner. Again, while chemists are already often to be found in the ranks of the inspectors, it is difficult to see what would be gained by the formation of a specialized branch of chemical inspectors as suggested by Dr. Djang, or what the recruitment of a section of industrial psychologists could do that could not be done equally well or better by means of the existing relations with the National Institute of Industrial Psychology. Of other suggestions made by Dr. Djang may be noted his plea for more educational work in the factories among the workers, employers and the general public, the study of labour problems from a wider field than that of the factory, and closer co-operation between the Factory Department and the International Labour Office. Mr. W. A. Robson's admirable introduction directs attention to an important point upon which the success of the system, however, may largely depend, although it is almost passed over by Dr. Djang, namely, the action of the courts in enforcing factory legislation, although the book includes examples of the failure of magistrates adequately to enforce the law and impose penalties for its breach.

As a contribution to the wider education of public opinion and the sympathetic understanding of the work of the Factory Department, upon which the effective support of its work, either in the factory or on the bench depends, this volume should be warmly welcomed. From scientific workers it well merits further attention as a highly suggestive study of a system in which scientific officers can render technical service to the State on terms which permit them to retain their professional independence and integrity.

R. BRIGHTMAN.

ROMANTIC GEOLOGY

Biography of the Earth

Its Past, Present and Future. By Prof. George Gamow. Pp. xiv+242+27 plates. (New York: The Viking Press; London: Macmillan and Co., Ltd., 1941.) 12*s*. 6*d*. net.

IN his book on "The Birth and Death of the Sun", Prof. Gamow revealed himself as a witty and enthusiastic writer with a remarkable flair for successfully popularizing current problems of stellar evolution. He has now applied his lively style of exposition to the life-story of the earth. The book deals broadly with the age and origin of the earth; the birth of the moon; the internal structure of the earth; the origins of mountain ranges and continents; climatic changes; the origin and evolution of life; and the final melting of the earth "in the last desperate explosion of its dying parent"—the sun. The narrative is as vivid and exciting as before, but this time, unfortunately, it is no longer sustained by an adequate background of expert knowledge. In consequence the book is seriously marred both by carelessness as to facts and by an uncritical adoption of many highly speculative hypotheses.

Thus the old view that the Pacific is the scar left by the birth of the moon is accepted—and correlated with the restricted area of the continental masses—without giving the reader any hint of the grave difficulties which stand in the way of this otherwise attractive solution of one of the fundamental problems of geology. Nor is any mention made of alternative hypotheses bearing on the origin of the continents. The author does not appear to have heard of the convection hypothesis, as he fails to mention it either in this connexion or in relation to any of the other problems raised by the major relief and pattern of the earth's surface. Few geologists would now agree with Gamow that "there is hardly any doubt" that great mountain ranges are wrinkles of the crust formed in response to the contraction of the underlying plastic layers. Indeed, the remarkable illustrations on p. 119, purporting to show how mountains are formed, and recalling Descartes's highly erroneous conception of mountain structure (NATURE, July 2, 1938, Suppl., p. 26), clearly demonstrate that the process, as imagined by Gamow, produces nothing remotely like actual folded mountains.

It is a pity that the book was not 'vetted' by a geological friend before publication. Apart from controversial matters, we might have been spared "metamorphized" for *metamorphosed*; "crumbling" for *crumpling*; and such infelicitous statements as "the volcanic eruptions . . . were ejecting masses of molten granite". Occasionally the author is more humorous than he intended to be. On p. 145, for example, he tells us that "the name 'Cambrian' indicates simply that the deposits of that period were first discovered and studied in Cambridgeshire (England)". Another gratuitous blunder is the statement (p. 186) that Gunz, Mindel, Riss and Würm are the names "of the geologists who studied various advances of ice and after whom these periods are often called".

Read as a 'thriller', Gamow's book is highly entertaining; but the reader who knows little geology to begin with must be warned not to take it too seriously. As an imaginative biographical novel it has undoubted merits and teachers will scarcely fail to profit from its originality of treatment. But as a scientific description of the earth's evolution it is in many respects inaccurate and misleading.

A. HOLMES.

LAND DRAINAGE

The Principles of Field Drainage

By H. H. Nicholson. Pp. xi+165+12 plates. (Cambridge: At the University Press, 1942.) 12*s*. 6*d*. net.

BEFORE the outbreak of war the National Farmers' Union estimated that a quarter of the farm land of England and Wales could be improved by drainage. Since then a series of measures taken by the Ministry of Agriculture enables drainage work, approved by county war agricultural executive committees, to receive a 50 per cent Government grant. A start has been made on this urgent work but much still remains to be done, and a book on the principles of field drainage is to be welcomed at this time.

Mr. Nicholson and his colleagues in Cambridge have made a special study of the drainage of an area of heavy gault clay soil acquired by the University Farm in 1930, in a derelict state, and afterwards rehabilitated by mole drainage. Their careful observations of the effects on the soil structure produced by the passage of the mole plough points the way to large-scale improvement of our heavy lands by mole drainage now that the development of the powerful track-laying tractor has reduced the cost. They found that this clay soil is fissured to the depth of the channel for a distance of two or three feet on either side of it. This observation has helped to elucidate the process by which drainage water reaches the mole channels. Clay subsoils always tend to return to their natural condition, and mole drainage is essentially a cultivation operation which must be repeated at intervals. As such, it is a means by which a system of tile drains at a lower level may be kept in operation or even restored to working order.

The author does not deal with the technicalities of surveying or of drainage engineering. His aim has been to interest and assist those who have to devise, advise on, and supervise works of field drainage. He classifies the conditions under which ditches and drains are needed and discusses the different ways in which drains are laid. An account of the moisture properties of soil leads to a general description of the way field drains work.

While part of the text is new, several sections are reprints of articles and leaflets published from 1936 onwards. In consequence of this method of compilation there is unnecessary and tiresome repetition. A more logical development could have been achieved had the whole been written anew. Nevertheless this little book can be thoroughly recommended to the public for which it is written. It is well illustrated by plates and text-figures and is a valuable addition to the scanty bibliography of an important subject.

R. K. SCHOFIELD.

APPLICATION OF THE STUDY OF VIBRATION TO ENGINEERING DESIGN

Fundamentals of Vibration Study

By R. G. Manley. Pp. xii+128. (London: Chapman and Hall, Ltd., 1942.) 13*s*. 6*d*. net.

ACCORDING to the author's preface, this book is intended to be an introduction to vibration theory. The result, however, is in some respects not so much an introduction as a summary of material that is more amply discussed in the standard treatises.

Beginning with one degree of freedom and the effects of forced vibration and damping, the author passes on to two degrees of freedom, many degrees of freedom, continuous systems and complex vibrations. What is said about these matters is doubtless perfectly sound, but a book of this type stands or falls by the method of presentation rather than by the matter presented, and it must be recorded that the method here adopted, apart from a little amplification here and there, follows closely that of the standard text-books on the subject. It may be objected that the difficulty of presenting a subject of this nature from a new angle is a very real one, but the fact remains that there is little here to give the learner a clearer insight into vibration theory than he can pick up from the fuller work of Den Hartog, for example.

A more serious criticism of this book is that the author attempts too much. He tries to expound vibration theory and the necessary mathematics at the same time. It just cannot be done. According to the author, "no previous knowledge of differential equations is assumed, this troublesome part of the theory being dealt with by the powerful and easy method of operators" (which only means the standard *D* notation) and only a little more than matriculation mathematics is necessary. In view of the fact that the treatment covers such matters as the differential equation of the beam flexure and the use of Fourier series, the above statement is misleading. The gap is supposed to be bridged by a five-page appendix on "Some Pure Mathematics", and an eight-page appendix on "Some Applied Mathematics"; but the bridging is wholly inadequate.

As the avowed object of this work is to smooth the path of the beginner it is a pity that obsolescent, if not obsolete, units like poundals are mentioned neither the engineer nor the scientific worker has any use for the poundal. Also one feels that the introduction of a mass unit equal to the mass of 386 lb is more confusing than helpful. What is wrong with the slug, that is, the mass of 32·2 lb.? The learner will have no difficulty in converting inches to feet when I and E are given in inches.

One curious error must be pointed out, as it wil most certainly confuse the learner. On p. 8 we hav the statement

$$\text{“}m = \frac{\text{lbs.}}{g} = \text{lbs. ins.}^{-1}\text{ sec.}^{-2}\text{”.}$$

Obviously the symbol g stands here for the *ratio* o gravity acceleration to unit acceleration and is nondimensional, so that after division by g the dimensio is still that of mass, although now in slugs instea of pounds. This error is repeated twice in Appendi II where we find the statement,

"1 lb. wt. = g poundals,
where g has the value 32·2 ft./sec.^{2}".

Clearly, for plain dimensional consistency this ough to read, "where g has the value 32·2".

The inclusion of a few exercises at the end of eac chapter is a good feature that is enhanced by printin the answers at the end of the book.

PASTURE MANAGEMENT

Back to Better Grass

By I. G. Lewis. Pp. 68. (London: Faber and Fabe Ltd., 1942.) 3*s*. 6*d*. net.

THE author has succeeded in presenting a brie but very useful and readable guide to succes in the formation and management of pastures, o rather, leys. The ley is of vital importance in Britai to-day, from the points of view both of the natio and of the individual farmer, who should aim a maintaining the fertility of his land, while producin at a high level, and making satisfactory profits. Th author lays emphasis on the factor of fertility. B proper manuring, cultivation, and the use of suitabl seeds mixtures, highly productive swards are obtained which maintain a large head of stock, which, in turn produce a well-dunged and urinated sod; when thi is ploughed, heavy arable crops result. Such i rotational farming, which is the only true basis o successful agriculture in Britain.

The author discusses how success can be achieve at each stage, beginning with the preparation of th land for the seeds mixture, and ending with th management of the sward by correct grazing. Usefu chapters are given on the selection of seed of th right strains, on the time to sow, and whether to us nurse crops; and the book ends with a useful list o seeds mixture prescriptions for leys of various duration and classes of soil.

The book is very practical, and combines th valuable experience of the scientific man wit that of a commercial man who was prepared t stake his career on the soundness of his advice. I is, perhaps, unusual to direct attention to a writer' experience, but the fact that the author set up i business as a 'consulting agrostologist'—the firs business of its kind in the world—adds greatly t the value and interest of this book.

DARWINIAN EXHIBITION IN MOSCOW

By SIR ARTHUR KEITH, F.R.S.

I HAVE had the privilege of reading a series of messages cabled by Mikhail Petrov to the president of the Linnean Society in which a description is given of an exhibition now displayed in the Zoological Museum, Moscow, to illustrate phases in the life and work of Charles Darwin. The exhibition, which has been organized by Prof. Turov, director of the Museum, and his staff, is on a scale beyond anything ever attempted in Great Britain or in any other country; in the words of M. Petrov, it "symbolizes the ever-growing cultural relations of two friendly nations who are united in a struggle against Nazi barbarism".

The exhibition begins with illustrations of Darwin's home life in Shrewsbury; passes on to his life and work on board the *Beagle*; then there follows what may be described as an objective account of the evolution of Darwin's masterpiece—"On the Origin of Species". The structure and distribution of coral reefs receives the fullest treatment. These are only a few of the sections of this exhibition, which is designed to meet the needs of the public rather than of the expert and is evidence of the intimate place given to Darwin and his works in the cultural life of Russia. Nor is this taste for Darwinism an affair of the moment; in these pages (NATURE, April 23, 1932, p. 606) was recorded the signal honour done to Darwin's memory by the Soviet Government on April 19, 1932—the fiftieth anniversary of his death. That day "was declared a public holiday in the U.S.S.R." Is it not a strange thing that our aggressive enemy should have domesticated Shakespeare in Germany while our Russian ally has taken to her heart Darwin—so often and so wrongly accused of being an instigator of war? Tolstoy has won wide homage in English-speaking countries; we in Great Britain must bestir ourselves if his great merits are to receive the recognition that those of Darwin have met with in the U.S.S.R.

There is another aspect of the Moscow exhibition which deserves attention. The reception which the "Origin" was accorded by the leading men of science in Russia during 1861–64 is illustrated by extracts from their writings, and the influence of its teaching on leaders of thought and action is brought home by extracts from speeches. Marx and Engels, as is well known, were influenced by their study of the "Origin"; Lenin regarded Darwin as the man who "placed biology, for the first time, on a sound scientific footing". M. Stalin's verdict on Darwin, given in 1938, is of particular interest: "In its development, science can name a good many men who found courage and means to break old, and to create new conceptions and laws, despite all obstacles—despite everything . . . such as Galileo, Darwin and many others". The description which the Prime Minister gave of M. Stalin in Parliament on his recent return from the U.S.S.R. helps us to understand his verdict on Darwin. "Premier Stalin," said Mr. Churchill, "has a deep cool wisdom and a complete absence of illusion of any kind." May not this description be applied to Darwin? He daily searched the face of living Nature in order that he might have no illusions about the manner in which she dealt with living things.

The year 1842 was one of the most eventful in Darwin's life; our colleagues in the U.S.S.R. do well in marking its centenary. In January of that year he finished the manuscript of "Coral Reefs" and sent it off to the printers; in May he corrected the last proofs. His home was then 12 Upper Gower Street, which he entered when he married his cousin, Emma Wedgwood, in January 1839; in 1842 he had entered his thirty-fourth year, was the happy father of two children and had taken into his service Joseph Parslow, who was to remain a member of the family for forty years. Darwin was then in a wretched state of health; his brain was continually overworking itself; he hated London; he called it "smokey", "dirty" and "odious"; he was "house-hunting", hoping to find a peaceful spot in the country within twenty miles of London. It was in the summer of 1842, while on a visit to Maer and to Shrewsbury, that "I allowed myself to speculate on the subject [the origin of species] and drew up some short notes". It is true he had been collecting facts which might throw light on the problem ever since he finished his "Journal" in July 1837; but this pencil sketch, drawn up in the summer of 1842, was his first attempt to apply the theory of natural selection to the explanation of his facts. We may, therefore, regard the year 1842 as marking the birth of the "Origin of Species".

On returning to London, house-hunting was taken up in earnest, the choice finally falling on Down House, in the parish of Downe, Kent, "16 miles from St. Pauls". The purchase had two advantages—rurality and price. Down House, standing on eighteen acres of ground, cost £2,200—£1,000 less than any other place then available at this time. Darwin's income was well over £1,000 per annum, but he feared 'extravagance' above all things; he was a great naturalist, but when answering the queries put to him by his cousin, Francis Galton, in 1873, it was his business ability, not his aptitude for scientific inquiry, to which he gave prominence. Thus it came about that the Darwin household was moved from London to Kent, the flitting taking place on September 14, 1842—another reason for marking the present year as a Darwinian centenary. On entering his new and permanent home he set to work on Part 2, of the "Geological Report of the Voyage of the *Beagle* (Volcanic Islands)" and published a pioneer contribution to glacial action in Britain—"Effects produced by the Ancient Glaciers of Caernarvonshire". He was also busy with plans for improving Down House. Clearly, 1842 was a notable year in the life of Charles Darwin.

Early life at Down House was overcast by a tragedy in the Darwin family. Nine days after arrival Mrs. Darwin was delivered of her third child, which lived only three weeks. There is in the archives of Down House—which, thanks to the public spirit of Sir Buckston Browne, is now preserved as a national memorial—a letter written by Darwin soon after the birth of this child. The letter is addressed to Mrs. Horner, wife of Darwin's geological friend Leonard Horner. Its opening sentences are worthy of quotation because of the light thrown on the opening month in the parish of Downe.

"I am much obliged for your letter and most kind congratulations. . . . We are going on very well and Emma [Mrs. Darwin] is making a quicker recovery owing, I think, to country air, than she has ever done before. Our children are very well and Willy [eldest son, then nearly four years of age] approves of 'country House' very much. I think the place will suit us very well. We have found moving so expensive that I have not ceased to be thankful that we bought a very cheap house. It is the quietest country I ever lived in."

In this and in other letters of this period, Darwin gives glimpses of his new surroundings—of nightingales, of larks, of fields pink with sainfoin, others white with spread chalk. It may interest our Russian colleagues to know that within these last ten years larks have moved away from the Down House fields, nightingales have almost forsaken its orchard and its sheltering trees, the pink and white fields have taken on other colours, and the sky, so peaceful a century ago, now resounds to the beat of propeller blades—sounds which we counted a nuisance in peacetime but which now, in these days, fall as a comforting music on our ears. But for the courage which makes this music, Down House might well have suffered the sad fate which, in spite of the splendid fighting of the Russians, has overtaken Tolstoy's old home.

To return for a moment to the Darwin exhibition in Moscow. We are glad to note the prominence which Prof. Turov has given to the spirit of humanitarianism which was so deeply ingrained in Darwin's nature—his hatred of cruelty and his horror of slavery. His indictment of slavery is illustrated by a quotation : "What an honour it is for England to be the first of European Nations to completely abolish slavery". This sentence is apparently taken from a letter which Darwin wrote from the Rio Plata and, addressed to his elder sister Caroline on May 22, 1833 ("Life and Letters", vol. 1, p. 246). He tells his sister that "it is impossible to see a negro and not feel kindly towards him" and that he is "watching the results of the election", then taking place at home. "What a proud thing for England," he exclaims, "if she is the first European nation which utterly abolishes it [slavery]". Britain was the first, for in that same year Parliament abolished slavery in all British colonies and spent 20 millions of pounds in compensating the slave owners. His hot condemnation of Captain Fitzroy's defence of slavery very nearly brought his career of naturalist on board the *Beagle* to a premature end. Even Sir Charles Lyell, for whom he had an unbounded admiration and affection, was sharply and hotly reprimanded when in 1845 he wrote equivocally of an institution which Darwin felt to be criminal. Even in his books, particularly in the "Descent of Man" (the edition in front of me is Murray's reprint of the second edition, 1913), we see his humanitarianism influencing his scientific verdicts. For example, when discussing the preservation of the weak and unfit by civilized nations, he writes (p. 206): "Nor could we check our sympathy, even at the urging of hard reasoning, without deterioration in the noblest part of our nature". He believed that, in the struggle between our higher and lower impulses, "virtue will be triumphant" (p. 192). After describing the prolonged travail which has divided mankind into so many diverse races, he seems to welcome a movement which would undo Nature's evolutionary scheme. Here is an extract from the chapter which deals with the rise of "Man's Moral Sense" (p. 187) :

"As man advances in civilization, and small tribes are united into larger communities, the simplest reason would tell each individual that he ought to extend his social instincts and sympathies to all members of the same nation . . . there is only an artificial barrier to prevent his sympathies extending to the men of all nations and races."

Those who, like Mr. H. G. Wells, advocate 'Universalism' as a remedy from the evils from which we now suffer—particularly the scourge of war—may, on the strength of this passage, claim the support of Charles Darwin. But then, on p. 219, we find this statement : "As man suffers from the same physical evils as the lower animals, he *has no right* to expect an immunity from the evils consequent on the struggle for existence. Had he not been subjected during primeval times to natural selection, assuredly he would never have attained to his present rank". From the context of this passage, one infers that Darwin expected that man's evolutionary struggle was to continue.

There is, I admit, a grave fault in Darwin's presentation of his facts in the "Descent of Man". In the last sentence just quoted we see the emphasis which Darwin places on the agency of natural selection in the evolution of man—an emphasis which has so misled many modern men of letters. Darwin gives prominence to competition, selection, survival, extermination, to all man's antagonistic qualities ; but when we look into the contents of his longest three chapters—3, 4 and 5—we find they are devoted to the evolution of man's co-operative mentality—the evolution of those instinctive and emotional reactions which bind men into family groups, into independent tribes—which are but extended families, and sovereign nations—which are but overgrown tribes. In the evolution of man co-operation has played quite as important a part as antagonism. Darwin assumed that men—even in their prehuman state—lived in social groups, and all that has been learned in the last seventy years justifies this assumption; and that the instinctive and emotional reactions which bound them into isolated groups had been developed from those more primitive ties which unite members of a human family.

The main struggle in the evolution of man, therefore, was between tribe and tribe, and it was this competitive aspect of the problem which seized Darwin's attention. I could cite many passages to prove that he was equally alive to the co-operative machinery which was at work inside each evolving tribe. For example (p. 203), "a high standard of morality gives but a slight or no advantage to each individual man and his children over other men of the same tribe, yet an increase in the number of well-endowed men and an advancement in the standard of morality will certainly give an immense advantage to one tribe over another". Without morality there could be no co-operation of members of a tribe. In reply to a criticism which the late Lord Morley passed on the "Descent of Man" Darwin gave this answer : "I have endeavoured to show how the struggle for existence between tribe and tribe depends on an advance in the moral and intellectual qualities of the members and not merely on their capacity of obtaining food" ("More Letters", vol. 1, p. 326). In brief, if we could have looked inside the developing brain of an early tribesman we should have found a dual mechanism at work, one giving rise to mental qualities which induced co-operation in members of a tribal team and another which impelled these members to maintain their team intact at all costs.

Light is thrown on the difficult problem of combining co-operation with competition in a corporate body (for a primitive tribe is a close corporation of interbreeding individuals) by what is taking place in the modern business world. We may take our illustration from our banking businesses. Ever since Darwin's day there has been taking place, just as happened in recent millennia in the human world, a tendency to the creation of an ever-increasing size of the evolutionary units; local banks have been amalgamated, and local amalgamations have been swallowed by central concerns, so that now only a limited number of great competing units survive, which units we may compare to the great nations of to-day. These large corporations, being managed by self-electing directorates, are run, as a recent writer points out (*The Times*, "Private Enterprise", September 18 and 19, 1942), for the benefit not of the whole British community but for a section of it. The problem is how the whole community can be benefited and yet be free from the evils, or risks, of monopoly.

Nature had, and has, to face the same problem in the evolution of mankind. The directorate she instituted for her purpose is that combination of qualities we call 'human nature', in which co-operative and competitive inborn or instinctive tendencies work for the good of the community or tribe as a whole. To quote Darwin once more (p. 190), "The social instincts . . . no doubt were acquired by man, as by the lower animals for the good of the community".

THE EXPLOITATION OF MINERALS IN RELATION TO NATIONAL AND WORLD PLANNING*

By DR. L. DUDLEY STAMP

ALL minerals are won by what used to be called 'robber economy'. Man has no control over the location of minerals: his efforts are directed towards the discovery and subsequent winning of deposits the position of which is dependent upon the geological structure of the earth, or towards the utilization of deposits not previously regarded as 'economic'. Once any given deposit is exhausted it is not replenished.

Thus the social and economic consequences of the extractive industries are entirely different from those which result from industries connected with either the animal or vegetable kingdoms. In those cases, provided adequate care is taken, Nature replenishes the stores year by year and the dependent industries are afforded a marked degree of permanence. By the limited nature of the resources on which they depend, mineral industries, whether merely extraction or processing, or secondary industries based thereon, are essentially impermanent.

It is of considerable importance to distinguish between two groups of economic minerals. In the first place, there are those which occur in limited supply and where the object of mining is to remove *all*, or as much as is economically feasible, of the mineral. Into this category come oil, coal, iron ore (at least above a certain metal content), and most metalliferous ores. In the second place, there are those minerals which occur in such abundance that only parts of the available deposits are ever likely to be worked. Into this category come limestone (including chalk) for lime and cement, clay for bricks and tiles, slate, building-stones, road metal, sand and gravel.

In the international planning of mineral exploitation it is the first group which is concerned: the rocks and minerals of the second group are of the greatest importance, but nationally rather than internationally. In the minerals of the first group there is little choice in the siting of the works; in the minerals of the second group it is possible to plan the actual areas of working to a considerable extent—they are usually dictated primarily on economic grounds, especially in relation to transport costs, but where necessary may be planned in accordance with requirements of the national planning or the location of industry, the conservation of agricultural land, the preservation of amenities and other relevant factors.

Restricting attention to the minerals of the first group, those of which the object is to remove the whole or as much as possible, a definite cycle is associated with the working. This is, briefly, exploration, exploitation and exhaustion. With *exploration* and the early stages of exploitation comes a very rapid development, an influx of population, a spate of building and often of extravagant expenditure—indeed all the conditions associated with a 'mining boom' whether it be a gold rush, an oil boom, or simply the development of a new coalfield. The period of relatively steady *exploitation* may be short (as in the case of alluvial gold or tin) or it may be long—even running into a century or more (as in the case of a coalfield). If it is long, then social and economic conditions become stabilized, substantial towns are built and the whole community may go so far as to forget that its existence is primarily dependent on the exploitation of a mineral deposit. This is the position reached in many of the older coalfields of Britain. The period of *exhaustion* or approaching exhaustion is one of serious and inevitable maladjustments often resulting in much human suffering and misery, and which calls for careful thought and action—it cannot be left to right itself.

Thus the recognition of the right of the nations of the world to share the world's mineral resources carries with it the obligation of those nations to accept responsibility and to share the burden of whatever social and economic readjustments may be needed. There is, in other words, an obligation to safeguard the interests of human beings both during and after the exploitation of the minerals.

Most of the problems which arise, and some of the readjustments, can be illustrated, though on a small scale, in the British Isles.

(*a*) Tin has been won in Cornwall and the south-west since pre-Roman times. Exploitation reached its peak some seventy years ago and resulted in a large number of mines with their conspicuous pithead gear widely scattered over the wilder parts of the county. At least two not inconsiderable towns, Camborne and Redruth, grew up dependent primarily on mining. To-day most of the deposits are sufficiently near exhaustion that in pre-war years their exploitation had become uneconomic. As a mine approaches the later stage of its career, there is little money left after running costs have been met and, when the mine fails, none at all to remove the old gear and buildings, which thus become unsightly ruins marring the countryside. In the case of the Cornish tin mines, much of the skill, experience and capital released from local mines was transferred abroad—many Malayan companies are offshoots of Cornish parents and are often staffed by Cornish miners. Camborne and Redruth came to depend on foreign investments —one solution, perhaps a rare one, of this difficult problem.

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* Paper read at the Conference on Mineral Resources and the Atlantic Charter arranged by the Division for the Social and International Relations of Science of the British Association on July 25.

(*b*) Lead was won by the Romans and at this moment is being worked again in Cumbria and elsewhere. The position is much as with tin, except that there is here an additional complication: that of noxious effluents and poisonous fumes from smelting. The first promise often to destroy freshwater life, including valuable fisheries; the second may ruin agriculture as well as natural vegetation for miles round. The aftermath is terrible. The same is true of the extraction of salt, gypsum, and the associated heavy chemical industries.

(*c*) Iron ore. The once flourishing iron industry of the Weald has gone, leaving little or no trace; the iron industry of the South Wales coalfield is more recent and has left behind a solid core, in peace-time conditions at least, of unemployment. In the Black Country, the evils have been mitigated by the switch over to other industries. The latest phase of maladjustment in the iron industry is seen in Northamptonshire, where thousands of acres of good agricultural land are being left, after removal of the ore, a stony desert of steep ridges and valleys useless to man and beast and affording little hope even for useful vegetation or afforestation. Yet a limited expenditure, with the aid of modern levelling machinery of the type now being used on aerodromes, could restore this land to usefulness.

(*d*) Slate quarries, chalk quarries, and other scattered surface workings, including those for gravel and sand, raise especially questions of amenity and the need for regulation, including definite directions towards the location of industry, in national planning.

(*e*) Coalfields afford examples of the problems raised by mineral working at their most difficult. A coalfield develops slowly, and its development gives rise to such permanent towns and villages that the subsequent problems of readjustment are extremely difficult. So rooted are the human beings that the solution of the problem has tended to be, not the 'scrapping' of the settlements—which is the logical course—and the removal of the people, but the deliberate effort to bring industry of new types to the pool of labour thus available.

These examples, drawn from Britain, are sufficient to illustrate the far-reaching character of the human and economic problems raised by the apparently simple proposition of sharing the world's mineral resources. It would seem that three principles emerge:

(1) Mineral exploitation inevitably results in a need for restoration, whether it be of land or of the social structure of the community.

(2) This restoration should be obligatory on those, whether nations or individuals, who derive benefit from the working of the minerals.

(3) In the latter stages of mineral exploitation there is never a surplus of money, and therefore there should be some provision, comparable to an amortization insurance, made when the industry is flourishing, for use in the later stages for the work of restoration and rehabilitation.

A STUDY OF ACCIDENTS

EMERGENCY REPORT No. 3 of the Industrial Health Research Board* is concerned with the problem of accidents, always important but still more so in war-time, when many circumstances combine to increase the risk of accidents. There is a tendency on the part of many people to accept accidents as inevitable happenings; one has only to recall the indifference to road accidents before the War to realize this. For some time now, efforts have been made to render the environment in which the industrial worker spends his working time safer; the legal aspect is embodied in the Factories Act and the Ministry of Labour Regulations, while advice is given by factory inspectors and the Royal Society for the Prevention of Accidents.

The report on accidents falls into two parts: the first part concerns itself with the general factors likely to affect all workers in different degrees; the second part deals with the individual differences which result in reactions which are not uniform.

General Factors affecting the Incidence of Accidents

(1) *Hours of work.* During the War of 1914–18 investigations showed that unduly long hours led to an increase in the accident-rate, and there is evidence that fatigue was largely responsible. In war-time longer working hours are necessary, but there comes a point past which it is no longer profitable to let people work. Fatigue not only reduces the speed and accuracy of muscular movements, but also affects mental alertness.

(2) *Heating and ventilation.* The number of cuts and minor accidents increases with temperatures much above or below the range of 65–69° F. Where processes generate much radiant heat the worker should be protected. Adequate ventilation should not be regarded merely as a side issue.

(3) *Lighting.* Lighting so inadequate that the worker cannot see his work effectively is a contributory cause of accidents. Too great a variation in lighting must also be avoided. Natural lighting, that is, daylight, is ideal when there is enough of it.

(4) *Speed.* Speed of production is a frequent cause of accidents, and since it is necessary in modern industry, care must be taken that machines are not moving too quickly, nor workers put on to speeds to which they cannot adjust themselves.

(5) *Inexperience and age.* Both these conditions are related to accidents, but are independent. People, whatever may be their age, if inexperienced at industrial work, are known to have a higher accident-rate than a similar group of experienced workers. Also young people, whether experienced or not, are more liable to have accidents than older people, partly because they are less responsible and partly because they have less control over their muscles. Therefore there should be adequate training for beginners, whether young or not, and adequate supervision for the young.

(6) *Fitness for the work.* Quite apart from physical unfitness a worker may be mentally ill-adapted to his work. There is evidence that workers of high mental ability, if employed on repetitive work demanding little thought, become bored, which state

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* The Personal Factor in Accidents. Emergency Report No. 3. Industrial Health Research Board. 1942. 4*d*. net.

leads to a variable output, fatigue and therefore to a high accident rate. This question of fitness is connected with that of vocational selection, to which far too little attention is paid.

(7) *Attitude of management and workers.* Both management and the workers have a part to play in accident prevention. If the former takes up the attitude that accident prevention is not an essential part of production, then there is little likelihood of a serious reduction even though lip service be paid to safety committees.

On the other hand, even proficient workers often neglect to take safety precautions because each works on the very human principle of "It can't happen to me". Although a worker may be very proficient, that does not connote an immunity to accidents ; a temporary lack of thought due perhaps to slight physical ill-health or mental pre-occupation may have serious consequences. Also the expert workers have a responsibility for the less expert, since these, particularly if young, tend to imitate the former. Care is not synonymous with fear.

Accident-proneness

When all the above causes have been considered there yet remains a factor that has been dimly recognized but until recently ignored. Everyday experience or the examination of accident statistics makes it clear that, given similar conditions of environment, or of the other factors already mentioned, there are people who have more accidents than their fellows. This difference is attributed by some to chance or to the effect of a first accident on a person's liability to another. Scientific analysis has, however, shown the special importance of a condition which is now known as 'accident-proneness'.

Statistical workers were the first to study systematically the unequal distribution of accidents among people exposed to the same risks. It is obvious that the accidents studied have been chiefly minor ones, since fortunately major accidents are not sufficiently frequent during a reasonable period of observation. Where, however, it has been possible to relate major accidents with minor ones, it has been found that those who had many of the latter also had an undue number of the former. Efforts made, therefore, to prevent people specially susceptible to accidents from dangerous work will protect them both from major and minor accidents.

Accident-proneness must be distinguished from accident liability. Liability to accident is largely determined by the degree of risk to which a person is exposed. Differing environmental conditions alter accident liability quite apart from any personal characteristics predisposing towards accidents. Although general liability differs from one group of workers to another according to the nature of their occupation and working conditions, yet in any one group of workers, however great or small may be the risk, some have more than their fair share of the accidents.

Psychological investigations have shown that those with an unduly high accident rate can be partly differentiated on the basis of measurable individual reactions.

So far only one factor of this accident-proneness has been identified and measured ; others may eventually be measured ; some may never be. For nearly twenty years investigators have been experimenting to find some test or group of tests to serve as a means of predicting this minority. Tests used to measure the capacity to respond accurately within a controlled time interval to various sensory stimuli have given reliable results in the case of skilled workers. In skilled occupations those who do well in the tests have been found to have, not only a lower accident rate, but also a higher rate of proficiency than those who do badly. Unfortunately, the tests cannot select all the accident-prone, though they do select a fair proportion.

There is no question of not employing the accident-prone ; they are perfectly normal people who can be usefully employed in most occupations, but if employed in an occupation with a high accident liability they are a danger to themselves and to others.

Accident liability is the sum total of all the factors determining accident incidence ; accident-proneness refers solely to the individual factors affecting it.

There are two ways of partially predicting the accident-prone. One is by finding the number of accidents sustained by each individual in a working group during a previous period of exposure ; the other by using certain tests. The most effective way is to combine both methods. This procedure has been shown in both transport and industrial accidents to reduce the subsequent accident rate to an appreciable extent.

It must be emphasized that if proper use is to be made of our knowledge it is most important that adequate records should be kept. Quite apart from the humanitarian aspect of accident prevention, a reduction in the working time lost would have a beneficial effect on production. MAY SMITH.

OBITUARIES

Dr. S. G. Barker, O.B.E.

THE world of fibres in its industrial development lost an outstanding personality and one of its greatest authorities in the sudden death, on August 28 last, of Dr. Sydney George Barker, scientific adviser to the Indian Jute Mills Association since 1934. Prior to taking up this appointment, the late Dr. Barker had been director of the Wool Industries Research Association, and most of his scientific and business life during the last twenty years was occupied in conducting and controlling investigations into the sources, preparation, properties and commercial utilization of the scarcer—principally hard—fibres.

Dr. Barker was born in York in 1887, of typical Yorkshire Nonconformist stock, and, throughout his life, he displayed all the sterling qualities and rugged honesty of character and purpose of his origin and upbringing. His early education in York was followed by study—principally of physics and mathematics—at the Imperial College of Science and Technology, London, and at the University of Berlin. He was one of the early holders of the research scholarships, tenable in German universities, instituted as a result of the efforts of the late King Edward VII to bring about a closer understanding between the two countries. Academically, although he won a number of distinctions, his progress was marked more by the steady and sustained effort of his acutely critical and inquiring mind than by any brilliant scholastic achievements.

In 1915, Dr. Barker began that long connexion with India and Indian industries which was to continue until the close of his life. He became director of industries to the Government of Travancore and produced for that Government a monumental "Survey" of the industrial possibilities of the province.

His sound judgment and acute perception of essentials in technological and industrial matters led to many calls upon him by various Indian Provincial Governments, and his work for these is embodied in more than fifty bulletins and papers on chemical and allied industries for State Departments and other official bodies. Dr. Barker, with his wife, whom he had married in 1915 before he sailed from England, threw himself wholeheartedly into all the activities of his surroundings, and served for some time as an officer of one of the local regiments. He was, for a period, vice-principal of the Maharajah's College at Trivandrum (University of Madras) and took an active part in its development.

In 1921, a breakdown in health forced Barker to return to England, and he began to suffer from the deafness which, in later years, became a severe handicap to all his activities. On his arrival in this country, he served for a time as principal assistant in the Research Department of Woolwich Arsenal. In 1926, he took up what was to be one of the great successes of his career—the directorship of the Wool Industries Research Association in Leeds. His brilliant work in this post, his devising of new processes and improvement in old ones, his invention of instruments and methods of testing, his work in organizing and compacting manufacture, resulted in notable progress in this fundamental industry, and established the Association as an indispensable factor in the development of sheep breeding and rearing and the improvement of the quality of the wool fibre throughout the British Empire. During this period also he worked in the closest association with and for the (now defunct) Empire Marketing Board, for which he examined many possibilities in the utilization of various fibres produced in different parts of the Empire. For this work he was awarded the O.B.E.

In 1934 he was invited to act as scientific adviser to the Indian Jute Mills Association, a position which he held to the time of his death. He visited India in 1935 and again in 1938 to establish and extend laboratories and supervise research and development schemes on behalf of the jute industry, and, on his return, he set up similar laboratories in Great Britain, supplementing and controlling the work in Calcutta. In this industry, as in the case of wool, he was responsible for rapid and useful progress, until the outbreak of war gave an already busy life still more work to be undertaken. He was appointed to various official advisory posts chiefly connected with the use of textiles and fibres in the war effort, and he was never lacking in suggestion and in the organization of inquiry whenever problems were encountered in which these products could be of use. His increased work caused him to suffer still more from deafness and from general ill-health until, in the course of completing an official journey to the north, he collapsed and shortly thereafter passed away.

Dr. Barker was a prodigious worker with an extraordinary memory for unusual items of information likely to be of use in his researches, and an energetic, cheerful and loyal colleague. He covered a wider range of scientific and industrial investigation during his life than is given to most men to achieve, and his success in what he undertook was recognized by the many honours conferred upon him and by membership of a large number of scientific and technical societies and committees, both at home and abroad. His output of written contributions to knowledge includes two monumental works on "Wool", and treatises on "Coir", "Sisal" and "Jute", in all of which fibres he was the world's foremost authority. Besides these works, he has to his name more than two hundred shorter papers, brochures and reviews of a less comprehensive character.

His death at this time, when his knowledge and experience were of so much value to the national war effort, is a grievous loss, and the thought that his passing was due solely to the intensity of his striving to help, is a tragedy. He leaves a widow, but no family.

Prof. Ludwig Aschoff

Prof. Ludwig Aschoff, the eminent German pathologist and medical historian, whose death at Freiburg im Breisgau was recently announced, was born in Berlin on January 10, 1866. He received his medical education at Bonn, Strassburg and Berlin and qualified at Bonn in 1889. After serving as assistant in Recklinghausen's Pathological Institute during 1891–1893 and at the pathological institute at Göttingen from 1893 until 1903, he was appointed professor of morbid anatomy at Marburg and at Freiburg im Breisgau three years later. His principal work was a system of morbid anatomy, of which he was editor and to which he contributed the articles on disorders of the circulation, inflammation, the heart and pericardium, urinary system, female sexual apparatus, and the digestive system. The eighth edition appeared in 1936. His other publications included works on appendicitis, cholelithiasis, thrombosis, scurvy, and a history of medicine in tabular form, of which the third edition in collaboration with Prof. Paul Diepgen was published in 1936. He was also editor of *Beiträge zur pathologischen Anatomie und zur allgemeinen Pathologie* and co-editor of *Veröffentlichungen aus der (Kriegs-) Gewerbe- und Konstitutionspathologie*. Aschoff's name is attached to an organ in the paradidymis and paroophoron, rheumatic nodules in the myocardium and lungs and with that of Tawara to the atrioventricular node in the heart. J. D. Rolleston.

We regret to announce the following deaths:

Mr. F. W. Clifford, librarian of the Chemical Society, on September 21.

Prof. E. Fawcett, emeritus professor of anatomy in the University of Bristol, on September 22, aged seventy-five.

Prof. P. A. Hillhouse, professor of naval architecture in the University of Glasgow since 1921, on September 28, aged seventy-three.

Prof. W. J. G. Land, emeritus professor of botany in the University of Chicago, known for his work on tropical plants, on August 1, aged seventy-six.

Dr. Henry G. Knight, chief of the Bureau of Chemistry and Soils of the U.S. Department of Agriculture, on July 13, aged sixty-three.

Prof. David Waterston, Bute professor of anatomy in the University of St. Andrews, on September 4, aged seventy-one.

Prof. H. D. Wright, professor of bacteriology in the University of Liverpool and City bacteriologist to the Liverpool Corporation, on September 9, aged fifty-one.

NEWS and VIEWS

The Church as a Social Force

THE mass meeting held at the Albert Hall, London, on September 26, was convincing evidence of the keen interest that is shown in the Church as a social force, especially in view of the fact that many times more applications for tickets were made than the huge hall could accommodate. The Archbishops of Canterbury and York and the Lord Privy Seal were supported by ambassadors, bishops and representatives of various religious bodies, commerce and industry at this meeting, which was arranged and organized by the Industrial Christian Fellowship as a sequel to the Malvern Conference of 1941. The Archbishop of Canterbury, who has shown a keen interest in, and done splendid work for, the social life of the country, and has already made valuable suggestions towards social reconstruction, emphasized that the Church has both a right and a duty towards declaring and supporting those principles which should govern the order of society. This is, after all, the natural sequence to the universally recognized duty of the Church to lay down principles for the conduct of individuals, the only difference being that the Church should now extend her influence to society, that is, groups of individuals. In the past, by ignoring society, fellowship has either not been fostered or has been broken where it existed, thus resulting in gross disparity of wealth and poverty, lack of leisure and so forth. The predominant motive guiding enterprise in the past has been that of profit. In the future, this must be put in its proper place, for it is not only an expression of selfishness but is also clearly not in the general interest. For the promotion of the general welfare there are two special problems, namely, land and money. The traditional Christian principle still holds good, that the right of property was a right of stewardship—never exclusive use. Therefore the Uthwatt Report, which aims at the combination of the advantage of public ownership and ultimate control with private initiative, is to be welcomed. So far as money is concerned, banks, now more or less amalgamated, should be limited in power to the amount deposited by their clients, while the issue of new credit should be a function of public authority.

The Archbishop of York spoke on housing and planning, stressing that a gigantic urban housing programme will have to be organized as soon as hostilities cease. The problem, however, already exists, both in town and country, and if there is any hope of demobilized men settling down to life in the country then steps should be taken to provide houses in rural districts even during the War. But housing must be planned. In this connexion we have as an example the disastrous mistakes made after the War of 1914–18. Further growth of already overgrown towns must be discouraged, while the decentralization and dispersal of new industries must be encouraged. New towns must be real communities centred round church, school and guildhall. Agricultural land and national parks must be earmarked, and, if necessary, private interests overruled.

Sir Stafford Cripps emphasized the recent enormous growth of the social conscience of the churches. So now it is for the Church to provide the moral force and the driving power for social and economic developments. The Church might well adopt as its Christian objectives the five "simple desires of the people of America" as expressed by President Roosevelt, namely: equality of opportunity; jobs for those who can work; security; ending of privileges for the few; preservation of civil liberties for all. If the Church agrees that these objectives are the embodiment of fundamental Christian principles, then nothing should stand in the way of their realization. Sir Stafford suggested that perhaps the Church herself is standing in the way; for example, if privilege is to be ended, then the Church herself must be prepared to give up her privileges with the rest, not excluding the privilege of endowment and of establishment.

The Bishop of Bristol gave an account of the growth and activities of the Industrial Christian Fellowship, and Miss Knight-Bruce spoke on "Education in the New Order". The substance of all the addresses given at the meeting is contained in a pamphlet entitled "The Church Looks Forward", published by the Industrial Christian Fellowship, 1 Broadway, Westminster, S.W.1, price 6*d*. It is hoped to discuss this pamphlet at greater length in NATURE shortly.

Natural Sources of Rubber

AN interesting note on possible West African sources of rubber is contributed to *Farm and Forest* (3, No. 2, June 1942) by J. H. Mackay, the general editor, who is on the staff of the Forest Department, Nigeria. Latexes vary in the proportion of resin and caoutchouc they contain, the more resinous providing the bird limes of the West African native. 'Ate', the coagulated latex of the vine *Carpodinus hirsuta*, has been in demand since the outbreak of war for trapping moth pests of stored cocoa, but it was formerly exported as a 'paste' rubber. The latex of *Ficus platyphylla* yields the Niger gutta of commerce; for this a former demand for use in the manufacture of chewing gum shows signs of reviving. It contains some 13 per cent caoutchouc. *Funtumia elastica* is the only indigenous rubber yielding tree; in 1896 some three thousand tons of rubber was exported from it but the yield fell owing to ruthless tapping.

Various lianes of the same family (Apocynaceæ) also yield excellent rubber. In cultivation the yield of rubber from Funtumia was only about 60 lb. of dry rubber to the acre compared with several hundred pounds from Hevea. *Hevea brasiliensis* was introduced into Lagos in 1894 and in 1938 exports from the Cameroons and Nigeria exceeded three thousand tons. The Benin Sands have proved particularly suitable for its cultivation. A recent publication by Muriel E. Whalley (*Nat. Res. Council*, No. 1071, Ottawa, 1942) may be of general use in connexion with the present widespread survey of possible natural sources of rubber. It surveys the various methods of extracting rubber from plants as recorded in the literature.

Control of Lantana in Madras

THE control of Lantana (*Lantana aculeata* = *L. camara*) and the spike disease of sandal have been occupying the attention of the forest officer in parts of the Madras Presidency for half a century. The Lantana was first introduced into India from Ceylon (it is a native of Central America) in 1833 as a garden plant. Its spread through peninsular India was almost meteoric and it has become naturalized throughout the whole country. Its importance as a forest pest was first voiced in 1893, and since that period many attempts, mostly abortive, have been made to deal with it. From 1934 research work with chemical methods has been carried out. These investigations were at first published in the *Indian Forester* but are now reproduced with the figures in "The Control of Lantana by a Sodium Chlorate Spray", by A. L. Griffith, sylviculturist, Forest Research Institute, Dehra Dun (*For. Bull.*, No. 106, Sylvicultural Series, Govt. of India Press, Calcutta, 1941). The importance of the investigations will be evident by the rapidity of the spread of the pest. In north Salem, where the work has been undertaken, it is recorded that in the north Salem forest division in 1917 there were 4,800 acres of Lantana. In 1935 the area had increased to 56,000 acres, while in 1941 it is stated that a very recent estimate put the area at just over 100,000 acres. This was the area in Government Reserved Forest only in the district. The density of the Lantana is often as much as 5,000 to 10,000 stems per acre. The experience gained so far shows that successful control by spraying with sodium chlorate is possible at a cost roughly of £10 per acre and that such a spray has no toxic effect on subsequent rejuvenation on the area. The results of this piece of research appear to be important. The Bulletin gives full details of the methods of applying the spray.

Psychiatry and Alcoholism

In a recent paper (*Virginia Med. Monthly*, 69, 417; 1942), Dr. Merrill Moore, associate in psychiatry at the Harvard Medical School and director of research at the Washington Hospital for the Treatment and Prevention of Alcoholism, declares that the three greatest public health problems in the United States to-day are tuberculosis, syphilis and alcoholism. Although the first two have received continuous attention from the medical profession during the last twenty years, alcoholism has not yet been completely accepted as a medical problem. According to Dr. Moore, acute or chronic alcoholism seems to result partly from the psychological inadequacy of the individual, and is therefore most likely to be found in persons who in childhood have been over-protected, too strongly dominated or pampered by over-solicitous parents. Prolonged drinking usually results in some form of neuropsychiatric disorder, which may be an avitaminosis, such as alcoholic neuritis, or pellagra caused by faulty diet, or there may be a frank alcoholic psychosis such as Korsakow's syndrome.

The frequent association of mental disease with alcoholism is shown by the fact that 60 per cent of all patients admitted to Massachusetts mental hospitals in the last twenty-five years gave a history of alcoholism. The high cost of alcoholism to the taxpayer is due to the fact that most alcoholic men and women are cared for in State or municipal hospitals to which they make no payment, and relief is required for the families and dependants of alcoholics whose income and earning power have been lost. Moreover, the cost is increased by the maintenance of courts for the distribution of drunkards in penal institutions. Dr. Moore maintains that there is a great need for the establishment of special clinics and hospital facilities for the treatment of alcoholics. At present they are not welcomed for treatment unless they can afford the necessarily high cost of private institutions, nor are they accepted at most State institutions unless they are suffering from alcoholic psychoses or equally severe mental illnesses in which alcoholism plays a secondary part.

The Journey of the Sun

Ralf E. Wilson discusses the motion of the sun in the Galaxy in Leaflet No. 161 (July, 1942) issued by the Astronomical Society of the Pacific. Before 1900, all determinations of the apex of the sun's motion were based upon proper motions, that is, motions at right angles to the line joining the star to the earth; and many of these were poorly determined and affected by appreciable systematic errors. About 1910, previous determinations were superseded by the results of two major investigations. The proper motions of about 6,000 stars had been determined on a standard system, and the observations started early in the century had produced 1,200 radial velocities. The latter gave an apex about 9° south of that derived from proper motions, and part of the discrepancy was attributed to the fact that radial velocities referred almost entirely to stars brighter than magnitude 5·5, the proper motions including essentially all stars brighter than magnitude 6 and many fainter ones. As radial velocities became available for the fainter stars the discordance increased, and in 1925 was largely removed by the discovery of systematic errors in the proper motions. The most recent investigations show that the motion of the sun, with respect to the naked-eye stars, is towards a point at right ascension 18h. and declination + 30°, near o Herculis, with a speed of 12 miles a second. The actual direction in which the sun is travelling in its galactic orbit lies about 40° north and east of the position just given, and the speed is about 180 miles a second. The low-velocity stars, with reference to which the sun's speed is 12 miles a second, are members of the same galactic subsystem as the sun, and are also subject to the same amount of rotation. The rotation of the sun around the centre of the galaxy is completed in about 200 million years.

New Companion to μ Draconis

Dr. K. Aa. Strand, of Sproul Observatory, has reported the existence of a third companion in the double-star system of μ Draconis (*Sky and Telescope*, August). It is known only by the regular fluctuations from the expected motion of the two visible components, observations having extended over three years. The brighter components have a period of revolution of about 1,500 years and the new companion revolves around one of them at a distance of about three astronomical units. It is a dwarf star with a mass half that of the sun.

Electricity in the Annealing of Glass

A paper by E. S. Morris on the application of electricity to the annealing of glass bottles and containers (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 10; Aug., 1942) first explains the nature and primary importance of annealing processes as applied to commercial glassware, with particular reference to bottles and containers. Development stages, from heated brick arches to portable and continuous lehrs, are then described in the section on mechanical improvements. The application of controlled heat to the fused and moulded product is shown through the transition stages of coal, producer-gas and oil firing, to complete electrification of annealing lehrs. Insulation factors and methods; heat conservation and re-application; cooling graduations; economic and product quality considerations in favouring the application of electricity as a power and heating element, are all made subjects for explanatory data. A brief account is given of tumbler-edge glazing and enamelling, which involve the processing of pre-annealed cold ware.

An A.C. and D.C. Peak-Factor Meter

E. H. W. Banner (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 10; Aug., 1942) describes an electrostatic voltmeter type of instrument connected to give readings proportional to the r.m.s. voltage and designed to give a rapid indication of the peak factor (peak/r.m.s.). When the reading is steady, operation of a press-key introduces a rectifier into the circuit for peak voltage, and in the case of alternating current also introduces by a tapping $1/\sqrt{2}$ times the applied voltage, so that the voltage applied to the voltmeter is the same as for the r.m.s. position if the wave form is sinusoidal. In this case no pointer movement occurs and the scale may be calibrated as for 1·41 peak factor. Other peak factors may be added directly from the voltage scale. The application to rectified and smoothed direct current is also proposed, 'pure' direct current having a peak factor of unity. It is further proposed that 'impure' direct current may be specified by its peak factor rather than by the 'ripple', as no standard is laid down for the term 'ripple'. Conditions of use are considered and possible errors examined. The instrument is inherently accurate, as the voltmeter scale is used for both peak and r.m.s. readings and scale errors thus tend to cancel out. Tests have borne out the theoretical considerations.

General Health and Dental Hygiene in Mexico

In a recent paper (*Bol. Of. San. Panamericana*, 21, 643; 1942) read before the Third Medico-Dental Convention at Mexico City, Dr. Miguel E. Bustamante discusses the development of public health dentistry in Mexico. At the present time the Department of Sanitary Specialization, which is maintained jointly by the Public Health Department and the International Health Division of the Rockefeller Foundation, provides free dental care by the supply of full-time dentists. There are dental services connected with the school health services in forty cities, and in the Federal District dental clinics in dispensaries of the Ministry of Public Assistance are open to adults. In 1940 there were 31 dentists working exclusively for the co-ordinated services of the various States, and the Public Health Welfare and Education Departments employ an even larger number in the Federal District. Within recent years dentists have collaborated with doctors, sanitary engineers, nurses and laboratory workers in the task of preventive medicine instead of confining themselves to the treatment of patients already suffering from infections of the mouth. The increased interest taken in dental hygiene is shown by the attention given to the patient's previous diseases, the chemical composition of his drinking water, the kind of food he eats and, in the case of children, the health condition of the parents, and the diet of the child from an early age. Prenatal hygiene followed by correct child nutrition and prevention of contagious diseases such as measles, whooping-cough and smallpox, greatly contribute to dental hygiene.

Radiotherapy in Peru

The July issue of the *Boletín de la Oficina Sanitaria Panamericana* gives an account of the Peruvian National Institute of Radiotherapy which was opened at Lima on September 19, 1940. It is devoted to the study and prevention of cancer and to the promotion of specialized university training on the subject. It will be provided with all the modern equipment for the early treatment of cancer and will supervise educational and social work directed against this disease. The institute occupies a modern building containing five stories, and is equipped with apparatus for X-ray diagnosis, X-ray therapy and general radiotherapy, as well as with a general physiotherapy department. There is a laboratory for hæmatology, serology and histopathology, as well as clinics for general medicine, surgery, gynæcology, urology, gastro-enterology, otorhinolaryngology, stomatology, etc. A hospital contains a hundred beds for free and paying patients, and the number of beds can be increased if necessary. One floor has been reserved for the technical staff and nurses. By the end of June 1941 the institute had treated 575 persons.

Recent Earthquake Records

According to preliminary bulletins just received from the Central Station of the Jesuit Seismological Association at St. Louis, U.S.A. (director, J. B. Macelwane, *S.J.*), fifteen strong earthquakes were registered on the seismograms during the first quarter of 1942. Further, two strong earthquakes were registered during the early part of April. On April 8, from the readings of seismograms obtained at twelve observatories, an earthquake with initial time near 15h. 40m. 10s. U.T. had its approximate epicentre at lat. 11° N., long. 118·8° E., which is in the China Sea, west of Bacuit (Palawan Island), north of Borneo. On April 11 the seismograms from eight observatories apparently indicated two deep-focus earthquakes in close succession and having nearby epicentres. The first had initial time near 01h. 25m. 23s. U.T. and epicentre near lat. 15·2° N., long. 91·5° W., with depth of focus about 230 km. The epicentres of the earthquakes were thus very close to the volcano Tajuulcom in Guatemala (Central America).

Use of Specialist Journals

The council of the Association of Special Libraries and Information Bureaux (ASLIB), 31 Museum Street, London, W.C.1, is offering to give advice on the disposal of specialist scientific and other journals. Many important libraries, not only in Great Britain but also in other countries, have been damaged or destroyed by enemy action, and in consequence it has become increasingly difficult to obtain back numbers of specialist periodicals for consultation; current issues have also gone astray from time to time through postal and similar difficulties. Yet in many cases, private individuals receive copies of scientific papers which they do not wish to keep for more than a limited period. The Association therefore suggests that, as a first step, members of professional and learned societies should return unwanted copies of papers they receive as part of their membership to their societies. The societies would in this way be able to build up stocks of their own publications against the time when damaged libraries will be endeavouring to build up their stocks.

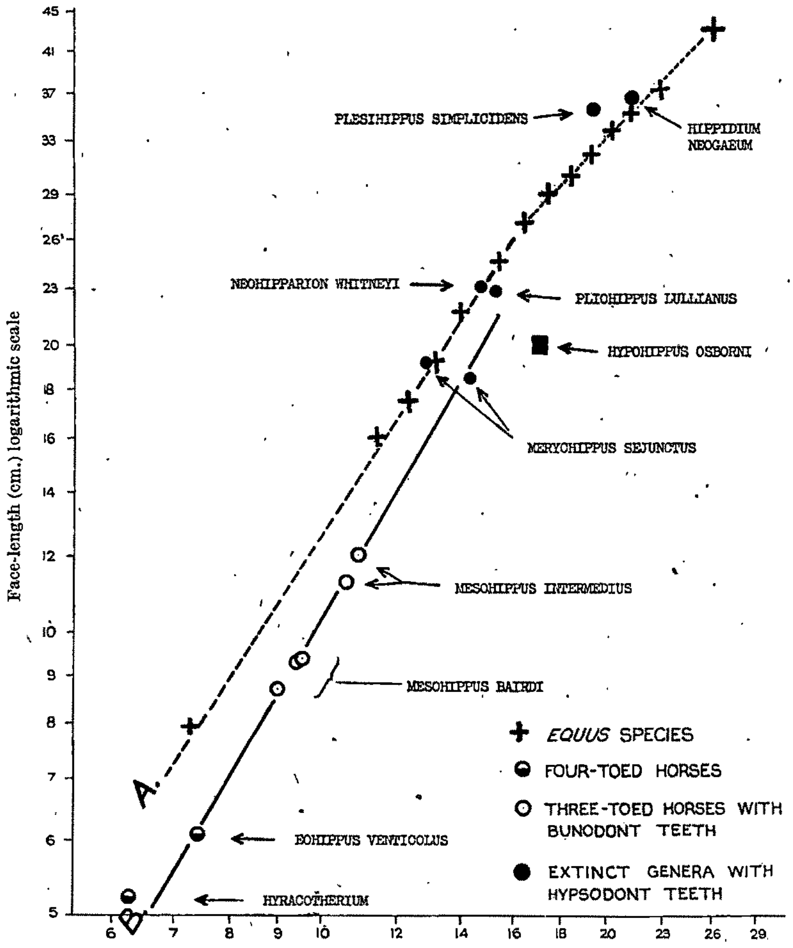
Erratum. The last paragraph in the News and Views columns of Nature of September 26 (p. 372) referred to the opening meeting of the new session of the Institute of Fuel, not the Iron and Steel Institute as printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Evolution in the Horse's Skull

ROBB[1] claimed that evolutionary changes in the horse's facial index (face-length/cranium-length) could be explained on the basis of a single law of relative growth of the face against the cranium, acting through mutations affecting solely an increase in general size. His argument is supported by a graph of face-length plotted against total skull-length for a number of fossil and modern horses, which on superficial examination seems to show that the two sets of points for phylogenetic and ontogenetic growth fall on a common straight line. Robb concludes: "One hundred million years of facial evolution may be summed up in the expression—slope = 0·66", but points out that a logarithmic equation would also express the size relation between face and cranium.



Careful inspection of Robb's graph suggests that the points do not follow a linear trend, and his method of plotting face-length against total skull-length, which includes the former dimension, will tend to obscure any exponential size relation between face and cranium. In fact, when face is plotted against cranium-length (= total skull minus face-length) on a double logarithmic grid, we get the results shown in the figure. Here, we have included all Robb's measurements of fossil horses except those stated by him to have suffered distortion in fossilization, and to his series of modern horses we have added measurements of seventy-six specimens from the British Museum and other sources. The measurements are those defined by Robb in his paper.

Members of the genus Equus have been grouped together, and means only have been plotted for successive size ranges of cranium-length (crosses on the graph). These means, and the number of specimens contributing to each, are shown in the table below. All points for other genera represent single individuals.

Points for Equus lie on a line (*A*) which has a slope of 1·5 up to a cranium-length of about 15 cm., when it becomes bent to the right with a slope of about 1·0; while a backward extension of the line passes extremely close to the single point for a very small fœtal horse. Of the primitive genera with low-crowned teeth, Eohippus and Mesohippus lie exactly on a line (*B*), which has a slope of about 1·8; while the single point for the European genus Hyracotherium lies quite close to this line, and probably does not deviate significantly from it, in view of the magnification of errors at the lower end of the scale with logarithmic plotting. The aberrant bunodont form Hypohippus lies well to the right of both lines. The other genera are advanced types with hypsodont grinding batteries, and all lie about the line of modern horses (*A*), except for one of the two points for Merychippus, which lies close to (*B*).

Clearly ontogeny does not repeat phylogeny in the evolution of the horse's face, and we propose the following modification of Robb's hypothesis. In primitive ancestral horses of the Eocene and Oligocene, the face grew with simple allometry against the cranium, the growth ratio being about 1·8. With the development of hypsodont teeth in the Miocene (Parahippus, Merychippus), a re-organization of skull proportions occurred, doubtless to make room for the enlarged and specialized grinders, and this seems to have been accomplished, not by an increased rate of facial allometry, but by an increase in the size of the facial rudiment at a very early stage of growth, followed by a lower growth ratio throughout the greater part of development. Further measurements may possibly show that the lines (*A*) and (*B*) should be parallel, that is, that the change was not accompanied by a fall in growth ratio. It is interesting to note that the re-organization did not occur when the premolars expanded and took on molar pattern in the late Eocene, but only with the evolution of a fully hypsodont grinding battery.

The position of the point for Hypohippus, Osborn's "forest horse", is remarkable. This genus appears to have sprung from a primitive Oligocene stock, was adapted to a forest life, or at least to soft ground and succulent food, and never developed hypsodont teeth. It has a face only three quarters the length of modern horses with the same cranium-length, possibly as a result of a falling off in relative growth-rate parallel to that already noted in Equus.

It is puzzling to find one point for *Merychippus sejunctus* on each of the lines (*A*) and (*B*), but several explanations are possible, such as an error of measurement, or high variability of skull proportions in this species.

The adolescent growth ratio of the face in Equus is not maintained to adult size, but declines quickly to isometry when the colt is 6–8 months old. While this may be an adaptation to increased size, preventing the face from becoming disadvantageously long, it is possibly a result of normal structural changes in late development, such as the eruption of the last molar or the closure of the sutures.

Our analysis has been limited by the fact that only Robb's measurements of fossil genera were available for study. Other indexes of face-length, such as prosthion to posterior edge of tooth arcade or to cribriform plate, might bring out a different aspect of facial evolution. Moreover, there are serious gaps in our data which could probably be filled in from the material in various museums, notably small fœtal specimens of Equus and stages between Mesohippus and Merychippus. Nevertheless, a remarkably close approximation to the allometric law is shown by both the primitive ancestral series and the few immature modern horses, and we publish this study in the hope that others will be able to fill in the main gaps and so test our conclusions.

MEASUREMENTS OF EQUUS SPECIES (IN CENTIMETRES)

Range	No. in group	Cranium-length	Face-length	Range	No. in group	Cranium-length	Face-length
7–9	1	7·3	7·9	17–18	16	17·5	28·8
10–12	3	11·5	16·1	18–19	15	18·5	30·1
12–13	5	12·4	17·5	19–20	13	19·3	31·2
13–14	5	13·3	19·3	20–21	4	20·3	33·8
14–15	4	14·1	21·8	21–22	10	21·3	35·1
15–16	10	15·5	24·5	22–25	5	22·9	37·3
16–17	12	16·5	26·9	25+	1	26·0	43·0

It is a pleasure to acknowledge our indebtedness to the authorities of the British Museum (Natural History), who kindly allowed us access to their collection of skulls. The original data will be deposited in the library of the Museum.

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St. Bartholomew's Hospital Medical College,
at the Zoological Laboratory, Cambridge.

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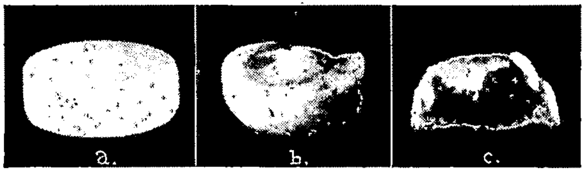
[1] Robb, R.C. (1935), *J. Genetics*, 31, 39 (1935).

'Ghost' Formation in Subcutaneously Implanted Tablets of Synthetic Œstrogens

THE method of administration of sex hormones by subcutaneous implantation of compressed tablets, first described by Deanesly and Parkes[1], is superior to regular injections in that the tablet, at least for some time, is slowly and continuously absorbed and supplies a relatively constant 'physiological' dosage of hormone.

The kinetics of tablet absorption have been studied[2,3], and the formation of fibrous capsules around tablets implanted into rats[3], rabbits[4], goats[5] and human beings[6,7] described. Geist *et al.*[6] believe that encapsulation may retard absorption and eventually prevent it altogether. Data collected in this laboratory on the absorption from tablets of diethylstilbœstrol and hexœstrol subcutaneously implanted into bovines have indicated that absorption falls off with time at a greater rate than can be accounted for by the decrease in the surface area of the tablet. Encapsulation, which has been observed in most cases, might account for this, but the new phenomenon reported below may be a factor of even greater importance.



(*a*) Tablet of pure hexœstrol, originally weighing approximately 1 gm., after implantation into a cow for 63 days.
(*b*) Ghost obtained by ether extraction of a similar tablet.
(*c*) Ghost cut in half showing hollow structure.

It was observed that tablets of hexœstrol or diethylstilbœstrol, which had been removed from bovines and, after careful cleaning, soaked in several changes of distilled water and dried at room temperature over calcium chloride, were not completely soluble in alcohol or ether, a flocculent residue remaining in suspension. When such a tablet was gently refluxed with alcohol or ether, it appeared to be insoluble, though it was evident that œstrogen was being extracted. The tablet gradually assumed a yellowish translucent appearance and eventually began to float.

Examination showed that the tablet now consisted of a fragile, hollow body of the same shape, and very little smaller than the original tablet (see accompanying illustration), but composed of ether-alcohol insoluble material. This structure, for which I propose the name 'ghost', is evidently formed *in vivo* by infiltration into, and deposition of tissue protein in, the pores of the surface zone of the tablet. Its presence in the tablet is invisible to the naked eye until the œstrogen 'skeleton' has been dissolved away.

In the desiccator the ghosts shrink considerably, forming horny masses which are insoluble in water, acids and alkalis. Tests for nitrogen, sulphur and phosphorus were positive. When a fragment is burnt, it first swells, chars and gives off a smell of burning wool. It probably consists mainly of a scleroprotein formed as a result of the reaction of the animal tissues to the presence of a foreign body.

As yet only tablets of synthetic œstrogens removed from bovines have been shown to contain ghosts. It remains to be seen whether this applies also to

DRY WEIGHTS OF GHOSTS FORMED IN HEXŒSTROL TABLETS SUBCUTANEOUSLY IMPLANTED INTO BOVINES

Wt. of tablet (*s*) after removal from animal (mgm.)	Absorption (mgm.)	Wt. of ether or alcohol extract (*a*) (mgm.)	Wt. of ghost (*b*) (mgm.)	Approx. percentage error in determination of the absorption. Calculated from	
				(*a*)	(*b*)
894*	172	810§	30·5	49	18
889*	172	855	19·5	20	11
742†	362	644	37·5	22	10
849‡	272	811	24·5	14	9

* Five similar tablets weighing 5,240 mgm. were implanted. The absorption from this single tablet is taken as one fifth of the total absorption.

† Twenty similar tablets weighing 1,104 mgm. were implanted.

‡ One tablet weighing 1,121 mgm. was implanted.

§ This extract was re-dissolved in ether, the ethereal solution repeatedly extracted with NaOH, then washed, dried over Na_2SO_4 and the ether distilled off. An oily residue weighing 13·7 mgm. remained. The ghosts may therefore contain some fatty material.

tablets removed from other animals or to tablets of steroid hormones.

Two points in connexion with ghost formation may be of practical importance. First, failure to allow for the weight of the ghost in determining absorption rates by weighing tablets before and after implantation may result in errors amounting to 10–20 per cent (see accompanying table). Second, it seems probable that the infiltration of the 'cortex' of the tablet with so insoluble a substance may considerably retard absorption and perhaps ultimately stop it completely. This would seem to be a likely explanation of the observation of Foss[7] (in the only case in which he used a tablet more than once) that an œstrone tablet removed from a woman and, after cleaning and sterilizing, implanted into another patient, underwent no further absorption.

The effect of ghost formation on absorption, together with the biochemical, serological and histological aspects of the phenomenon, are being further investigated.

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Vitamin C and Chromosome Number in Rosa

FIVE years ago Bukin and Zubkova[1] found that wild rose hips contained higher proportions of ascorbic acid when they came from the more northerly or more mountainous regions of the U.S.S.R., proportions rising in the Cinnamomæ group to 15 per cent of the dry weight. It had been known since Täckholm's work[2] that species, or rather forms, in Rosa with the more arctic or alpine distribution were the higher polyploids. Evidently in Rosa[3], as elsewhere[4], there had been a freer post-glacial colonization by the forms with higher chromosome numbers. It seemed therefore that an increase of chromosome number in the rose (as in the apple[5] and perhaps the tomato[6]) might inherently lead to an increase of vitamin production in the fruit, or in the plant generally.

The species named by the Russian chemists as having the highest vitamin contents are in fact recorded by cytologists in other countries as tetraploid, hexaploid and octoploid. Where, however, as in Rosa, polyploidy has occurred within the species, that is, without great morphological change, the systematic name has necessarily lost its genetic and physiological meaning. It is not possible therefore to test the effect of polyploidy until chemical and cytological examinations can be made on the same series of plants.

We are now nearer this goal with the chemical work of Pyke and Melville[7] on species of which representatives in Great Britain have also been examined cytologically. These workers likewise have found that the more northerly forms have the higher vitamin contents, even, they remark, when transplanted to the south. Their facts in relation to the chromosome numbers, so far as I can trace them, are summarized in the accompanying table :

VITAMIN C IN FRUITS OF ROSE SPECIES.

Section	Species	Ascorbic acid	Ploidy	Reference
Synstylæ	*arvensis*	0·08%	$2x$	11
Pimpinellifoliæ	*spinosissima*	0·34%	$4x$	11
Caninæ	*micrantha*	0·40%	$5x$	10
,,	*agrestis*	0·46%	,,	10
,,	*canina*	0·55%	,,	8, 11
,,	*dumetorum*	0·59%	,,	11
,,	*tomentosa*	0·69%	,,	11
,,	*rubiginosa*	0·81%	,,	10, 11
,,	*coriifolia*	1·08%	,,	11
,,	*Sherardi*	1·24%	$6x$*	9
,,	*mollis*	1·26%	$8x$*	9

* Scottish forms ; lower polyploid forms found in England

This provisional arrangement indicates that genetic differences determining vitamin content, irrespective of chromosome number, distinguish species within the Caninæ, but that these differences are of a lower order than those distinguishing the larger groups, Caninæ and Cinnamomæ. At the same time they indicate that polyploidy goes with, and may in itself determine, an increase in vitamin production. This conclusion can be tested by the experimental doubling of the chromosome number in diploid and tetraploid forms, and the results will probably have both particular and general value.

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Anemotaxis in Drosophila

Cole[1] has observed that *Drosophila melanogaster* sometimes walks against an air current. Flügge[2] showed that this reaction only occurred when the air was scented, and must therefore be regarded as orientation by smell. However, reactions to air currents without smell do occur in Drosophila.

Comparing several species of the genus, a division can be made between those which show a distinct positive anemotaxis and those which do not. *Drosophila virilis* +, *D. virilis americana*, *D. subobscura* and *D. funebris* turn very sharply towards a tube from which air is flowing and start walking against it, so long as they are not blown away. *D. melanogaster* and *D. buskii*, on the other hand, show no reaction, whereas *D. pseudo-obscura* shows a slight reaction.

Removal of the wings or antennæ or both does not abolish the reaction in the species showing it. Therefore Fraenkel and Gunn's[3] contention that anemotaxis depends on the perception of body deformation caused by the wind seems plausible for Drosophila.

The fact that the two light species observed do not react to wind whereas the four dark species do, may be an indication that the former are not exposed to strong air currents in their natural environment, while the latter are. As wind is a factor which increases evaporation, this is in agreement with some recently published deductions[4], to the effect that a dark cuticle provides better protection against desiccation than a light one.

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Nomenclature of Biological Movement

Having read recently with very great interest Fraenkel and Gunn's "Orientation of Animals", I set about making for my own clarification a classification of all the cases I know of what used to be called 'tropistic' movements.

It is clear that three major groupings are possible: a *taxis*, which is a bodily movement of an animal or motile plant in a direction determined by the direction of the stimulus; a *kinesis*, which is a change of rate of movement of an animal (or perhaps motile plant) in response to a change of intensity of a stimulus, but not in a direction determined by the direction of the stimulus—and often producing an aggregating effect superficially similar to that of a taxis; and an *orientation*, which is the placing of the body (usually if not always animal) in a direction determined by the direction of the stimulus. To these three classes many of the cases can be referred.

But the responses of sessile plant organs do not seem to be so conveniently classified. The thigmotropism of Clematis tendrils appears to warrant that name, for the response is a directional one. But the same cannot be said of the so-called 'thigmotropism' of Mimosa leaflets, Mimulus stigma or Berberis stamen, for here the response is not in a direction determined by that of the stimulus. The response in these cases appears to bear a closer resemblance to the photonasty of Oxalis leaflets and the thermonasty of Tulipa flowers. Is one then justified (disregarding—as often becomes necessary for purposes of coherence—mere etymological niceties) in putting these responses under the heading of 'thigmonasty' (or possibly in some cases—as in Stiles's "Plant Physiology"—'seismonasty')? By the same token may the response of Mimosa leaflets to a lighted match in the neighbourhood be called a 'thermonasty', and to ammonia vapour, a 'chemonasty'?

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An Inland Record of *Triglochin maritimum* L.

In a previous note[1] I recorded the occurrence of the halophilic alga *Percursaria percursa* Rosenv. from a salt-spring situated at Aldersey[2], Cheshire. Continuing the ecological survey of this spring, I am now able to report the presence of the halophyte *Triglochin maritimum* L. (Naiadaceæ). It occurs in three small colonies growing in the salt-spring and appears to be well established. I should add that during the past year the spring has maintained a salinity of 1,642 parts per 100,000 with only slight variation.

Triglochin maritimum, popularly known as seaside arrow-grass, is a plant frequently found in salt marshes. Its occurrence in a non-littoral region is exceptional and would seem to be unique in so far as the county of Cheshire is concerned. Search of the literature has revealed the fact that Triglochin has occasionally been recorded from the counties of Cambridgeshire, Staffordshire and Surrey.

In Cambridgeshire, the plant appears to have been first reported from Tydd Marsh by Skrimshire[3]. A. E. Evans[4], however, points out that it was never plentiful in that county and has not been found there during recent years. In Staffordshire, J. E. Bagnall[5] mentions records of Triglochin by the independent observers, Shaw, Stokes and Brown. In Surrey, C. E. Britton[6] records its discovery by W. A. Todd from the Thames near Putney.

I am indebted to Mr. A. A. Dallman, of Doncaster, for certain of the references quoted.

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Aug. 29.

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Existence of Electromagnetic-Hydrodynamic Waves

If a conducting liquid is placed in a constant magnetic field, every motion of the liquid gives rise to an E.M.F. which produces electric currents. Owing to the magnetic field, these currents give mechanical forces which change the state of motion of the liquid.

Thus a kind of combined electromagnetic-hydrodynamic wave is produced which, so far as I know, has as yet attracted no attention.

The phenomenon may be described by the electrodynamic equations

$$\text{rot } H = \frac{4\pi}{c} i$$

$$\text{rot } E = -\frac{1}{c}\frac{dB}{dt}$$

$$B = \mu H$$

$$i = \sigma(E + \frac{v}{c} \times B);$$

together with the hydrodynamic equation

$$\partial \frac{dv}{dt} = \frac{1}{c}(i \times B) - \text{grad } p,$$

where σ is the electric conductivity, μ the permeability, ∂ the mass density of the liquid, i the electric current, v the velocity of the liquid, and p the pressure.

Consider the simple case when $\sigma = \infty$, $\mu = 1$ and the imposed constant magnetic field H_0 is homogeneous and parallel to the z-axis. In order to study a plane wave we assume that all variables depend upon the time t and z only. If the velocity v is parallel to the x-axis, the current i is parallel to the y-axis and produces a variable magnetic field H' in the x-direction. By elementary calculation we obtain

$$\frac{d^2H'}{dz^2} = \frac{4\pi\partial}{H_0^2}\frac{d^2H'}{dt^2},$$

which means a wave in the direction of the z-axis with the velocity

$$V = \frac{H_0}{\sqrt{4\pi\partial}}.$$

Waves of this sort may be of importance in solar physics. As the sun has a general magnetic field, and as solar matter is a good conductor, the conditions for the existence of electromagnetic-hydrodynamic waves are satisfied. If in a region of the sun we have $H_0 = 15$ gauss and $\partial = 0{\cdot}005$ gm. cm.$^{-3}$, the velocity of the waves amounts to

$$V \sim 60 \text{ cm. sec.}^{-1}.$$

This is about the velocity with which the sunspot zone moves towards the equator during the sunspot cycle. The above values of H_0 and ∂ refer to a distance of about 10^{10} cm. below the solar surface where the original cause of the sunspots may be found. Thus it is possible that the sunspots are associated with a magnetic and mechanical disturbance proceeding as an electromagnetic-hydrodynamic wave.

The matter is further discussed in a paper which will appear in *Arkiv för matematik, astronomi och fysik*.

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Energy of Dissociation of Carbon Monoxide

THE energies of dissociation of a number of diatomic molecules have been determined from spectroscopic data, apparently with high accuracy, by the observation of predissociation limits. During the last few years the following values have been proposed for CO: $D(\text{CO}) = 6{\cdot}92$ [1], $8{\cdot}41$ [2], $9{\cdot}14$ [3], $10{\cdot}45$ [4] e.v.; while values of 9·85 and 11·11 also appear possible[3]. Controlled electron experiments suggest 9·6 [5].

The value obtained by extrapolation of the vibrational levels of the ground state is about 11, and support for this value has been given by Kynch and Penney[6]. Herzberg[7] has recently summarized evidence favouring 9·14.

At first sight, the strongest argument for 9·14 is the observation by Faltings, Groth and Harteck[8] that CO is decomposed by the xenon line at 1295 A., but not by that at 1470 A., from which they conclude that $8{\cdot}44 < D(\text{CO}) < 9{\cdot}57$. This conclusion is not based on an examination of the initial act of absorption. The only known absorption in the 1295 A. region is that corresponding to the fourth positive bands. The origins of the (9,0) and (10,0) bands lie at 76,839 cm.$^{-1}$ and 78,010 cm.$^{-1}$. The xenon line 1295 A. = 77,172 cm.$^{-1}$ falls between these bands and, if absorbed from the lowest vibrational level of CO, would correspond approximately to the line $P(35)$ of (10,0). This gives as the upper limit of $D(\text{CO})$ (when the rotational energy is taken into account) a value of 79,722 cm.$^{-1}$ = 9·88 e.v. (not 9·57 e.v. as stated by Herzberg[7]). Actually, it is doubtful whether such a high rotational line as $P(35)$ would be observed at room temperature, and absorption, if it is due to CO, would probably occur from a higher vibrational level, corresponding perhaps to the (13,2) band, in which case the dissociation limit may be placed as high as 10·1.

Taking the first act of absorption as

$$\text{CO}(X^1\Sigma) + h\nu = \text{CO}(A^1\Pi),$$

and assuming a life not less than 10^{-8} sec. for $A^1\Pi$, then at atmospheric pressure each molecule experiences at least 100 collisions before radiating. It seems to us that this gives a reasonable chance for a reaction such as

$$\text{CO}(A^1\Pi) + \text{CO}(X^1\Sigma) = \text{CO}_2 + \text{C}$$

to proceed with quantum efficiency approaching unity. The state of the carbon atom might be either ^1D or ^3P; the former if spin is to be conserved, the latter if not. In either case the reaction is strongly exothermic. The failure of the xenon line 1470 to induce photodissociation may be due to the reaction requiring an activation energy.

Estimates of $D(\text{CO})$ less than 10 take no account of the non-crossing rule of Hund, and Neumann and Wigner[9]. This rule states that potential energy curves of molecular states of identical species cannot cross. Whether the rule is rigorous when the nuclear and electronic motions are not separated needs further examination, but at least we see no reason for anticipating a failure of the rule in the lowest energy curve of CO. If this curve has only one turning point then the non-crossing rule requires unequivocally that $D(\text{CO}) > 10{\cdot}3$, and would agree well with the predissociation limit at 11·11 e.v.

The dissociation energy of CO+ is 2·6 e.v. less than that of CO ($D(\text{CO}^+) = D(\text{CO}) + I(\text{C}) - I(\text{CO})$). Three electronic states of CO+ are known, namely, $X^2\Sigma^+$, $A^2\Pi$ and $B^2\Sigma^+$, extrapolating to dissociation limits of about 9·8 (a very long extrapolation), 9·2 and 9·4 e.v. respectively. Since the two $^2\Sigma^+$ states must give different products of dissociation, it would appear, on the evidence of the $B^2\Sigma^+$ state, that $D(\text{CO}^+)$ is 7·4, and $D(\text{CO})$ is about 10, and on the evidence of the $A^2\Pi$ state that $D(\text{CO}^+)$ is 9·2 and $D(\text{CO})$ is 11·8. All that may fairly be deduced from present evidence on CO+ is that $D(\text{CO})$ is unlikely to be much less than 10.

We have also re-examined nitrogen. The accepted value $D(\text{N}_2) = 7{\cdot}38$ is based on the identification of the upper state of the Vegard–Kaplan bands with the

$A^3\Sigma$ level. This is at variance with numerous measurements of the excitation potential of the second positive bands[10]. Applications of the non-crossing rule to N_2 and N_2+ agree in giving $D(N_2)$ at about 9 e.v., but it is only possible to avoid crossing of the N_2 potential curve for $B^3\Pi$ and another $^3\Pi$ state dissociating to $^4S + {}^2D$ by assuming a small maximum in the $B^3\Pi$ energy curve. We incline to the opinion that many of the upper potential curves of CO and similar molecules must have more than one turning point: without such an assumption it is difficult to make the various lines of experimental evidence fit together. Details will be given later.

Summarizing, our suggestions are that $D(CO)$ lies between 9·85 and 11·11 e.v., and $D(N_2)$ is about 9 e.v.

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A Modified Patterson Function

Recently Yü has suggested in Nature[1] the synthesis of a new modification of the Patterson function, which has proved very useful in structure analysis of crystals. For the one-dimensional case, Yü's method is to calculate the modified function P_n given by the following series

$$P_n = \sum_h a_{nh} E_h \qquad (1)$$

at the points $X_n = \frac{n}{N}$, where N (taken to be an even number for the convenience of our discussion) is the number of equal sub-divisions into which the unit translation is to be divided, and the E's are the 'idealized' structure factors with atomic numbers replacing the appropriate atomic factors. When the constants a_{nh} are so determined that

$$E_h = \sum_{n=-N/a}^{+N/a} P_n \cos 2\pi h X_n \qquad (2)$$

for every vector h of the reciprocal lattice, the function P_n gives an approximate representation of the product $Z_i Z_j$ or a sum of such products corresponding to one or more interatomic vectors $r_{ij} = X_n$, provided that N is chosen sufficiently large and the series (1) is not cut off at too small values of h. These constants a_{nh} can be determined from the following relation:

$$\sum_{n=-N/2}^{+N/2} a_{nh} \cos 2\pi h' X_n = (-1)^h \cdot \frac{h'.\sin h'\pi}{\pi(h'^2 - h^2)}. \qquad (3)$$

Evidently, Yü's method admits of easy generalization to two- or three-dimensional cases, which require another set of constants b_{nh}, to be determined by the following relation:

$$\sum_{n=-N/2}^{+N/2} b_{nh} \sin 2\pi h' X_n = (-1)^h \cdot \frac{h.\sin h'\pi}{\pi(h'^2 - h^2)}. \qquad (4)$$

An obvious disadvantage of this method is the computation of these sets of constants for a moderately large value of N, which is undoubtedly very laborious.

I wish to point out here the simple limiting forms of the constants a_{nh} and b_{nh} when N is allowed to tend to infinity. Equation (3) takes the following form

$$\int_{-\frac{1}{2}}^{+\frac{1}{2}} a_h(X) \,.\, \cos 2\pi h' X.dX = (-1)^h \frac{h'.\sin h'\pi}{\pi(h'^2 - h^2)},$$

when N becomes infinite. It follows immediately that $a_h(X) = \cos 2\pi h X$. Similarly, $b_h(X) = \sin 2\pi h X$. It is thus obvious that (1) is an approximate form of Fourier representation of the 'idealized' Patterson function. It differs from the Patterson function in the fact that the E's (which can only be approximately determined from the experimental intensities) are used instead of the $|F|^2$'s; this difference accounts for the possible 'sharpening' of the Patterson peaks in Yü's modified function. Hence it may be inferred that (1) will not be more rapidly convergent than the Patterson function if the same degrees of approximation are to be attained; and that it will not entirely eliminate the diffraction effects inherent in the latter function or other related Fourier representations because of experimental limitations and uncertainties. Although I agree with Yü in realizing the desirability for a new interpretation of the Patterson function or related functions, it is my opinion that Yü's method does not offer a better solution to the structure analysis of crystals than the original function of Patterson.

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[1] Yü, S. H., **149**, 638 (1942). Cf. also a note on p. 729. The paper of S. H. Yü and C. P. Ho (*Science Records, Academia Sinica*, **1** (1942)) is not available here for reference.

Radiation from Flames

As is well known, R. von Helmholtz found that the radiation from carbon monoxide flames was nearly 2·5 times as great as that from hydrogen flames. This appears to be generally interpreted as indicating that carbon dioxide radiates more powerfully than water vapour[1]. But the opposite is the case; water vapour radiates twice as powerfully as carbon dioxide under similar conditions of temperature, etc[2,3]. Helmholtz's results (which at first sight are all the more surprising because hydrogen-air flames are some 100° C. higher in temperature than carbon monoxide-air flames) would appear to be due to the more rapid cooling of the hot products surrounding the outer cone in the case of hydrogen flames than in the case of carbon monoxide flames, for Hartley[4] has shown that the overwhelming proportion of the radiation from flames comes not from the interconal gases but from these hot products. It would appear that the more rapid the combustion the greater the turbulence in these products, and hence, owing to the more effective intermingling with the surrounding air, the more rapid the cooling.

Helmholtz also found that when the gases fed to the burner were pre-heated the amount of radiation from the flame was decreased—in spite of the fact that the flame gas temperature must be higher. He and others believed that this supported the view that the (infra-red) radiation from flame gases is of chemical origin, but there is now definite experimental evidence that it is due to thermal causes[2]. I think that the explanation of Helmholtz's pre-heating experiments is probably similar to that given above, namely, a more rapid cooling of the hot products outside the outer cone due to greater turbulence.

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[1] For example, Bone and Townend, "Flame and Combustion in Gases", (Longmans, Green and Co. (1927), p. 207); and Gaydon, "Spectroscopy and Combustion Theory" (Chapman and Hall, 1942), p. 93.

[2] David and Parkinson, *Phil. Mag.*, **15**, 177 (1933), and unpublished experiments.

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Publication of Scientific Research carried out by Industry

ON p. 322 of NATURE of September 12, Dr. Denbigh charges "many British firms" with refusing to allow their staffs to publish their scientific work. He proceeds to write of "industrial companies" without qualification, and to draw a general comparison between British and American industry. It seems, therefore, that by "many" he means "practically all". Accordingly, it should be pointed out that there is at least one important firm to which his statements do not apply, and, therefore, that evidence is needed to show that the practice he denounces is typical of British industry.

When I became an employee of the General Electric Co., Ltd., twenty-three years ago, I was impregnated with the academic tradition about publication. During those years I have had the fullest opportunity to observe the policy of my employers in this matter, and I can testify that I have never found anything contrary to the highest form of that tradition. Even those of them who are most fully imbued with commercial ideas, and might be expected to take the narrowest view of the company's interest, have realized that the indirect benefits of publication (one of them is a good reputation in academic circles) outweigh any direct benefits of secrecy. Publication in the academic sense has always been regarded as a normal activity of the research staff, and has been subject only to such censorship as a professor might impose on his students to prevent the publication of immature work. Apart from formal publication, the staff have always been encouraged to place their special experience at the disposal of individual academic workers to whom it might be of value. The only restriction, arising out of commercial considerations, has been a delay of perhaps a fortnight on a few occasions in dispatching a paper (or a letter to NATURE), in order to allow a patent specification to be filed.

I do not say that no detail of any industrial process has ever been kept secret; but the few secrets that have been kept (apart of course from those affecting national security) are, in my opinion, of no interest to anyone but a commercial manufacturer.

Those who are still under the delusion that secrets are the life-blood of industry may find it difficult to believe that any firm could long pursue so enlightened a policy. It may be well, therefore, to point out two things. First, the industrial use of many scientific discoveries can be adequately protected by patents, which involve publication. Second, most industrial problems have several alternative solutions. What a manufacturer usually would like to learn from his competitors is not simply how to do something, but the way of doing it that has been found the best. The method most scientifically interesting is by no means always the most commercially effective. By publishing scientific work that indicates some new alternative, a manufacturer does not disclose the method he is actually using.

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Scientific Literature for Enemy Prisoners of War

A SMALL organization has recently been formed[1] for the purpose of sending copies of scientific papers to scientists who are enemy prisoners of war in British hands. The idea is to keep alive the spirit of discovery, so that imprisoned enemy scientists may be helped to remain mentally active and thus become useful world-citizens again after the War.

All the authorities who have been approached have been sympathetic and helpful. This applies to the Director of War Prisoners, the Special Division of the Swiss Embassy concerned with the welfare of German, Italian and Japanese prisoners, Le Comité international de la Croix-rouge (London Delegation), and the War Prisoners Aid Section of the Young Men's Christian Association. The helpfulness of Mr. John Barwick, of the latter organization, must be particularly mentioned.

Scientists receive many reprints of scientific papers which they do not want to keep permanently. I should be most grateful for reprints, which would be directed through the proper channels to the appropriate scientists in prisoner-of-war camps. Fairly old papers would be useful as well as new ones. Enemy prisoners are unlikely to have seen British or American papers published later than August 1939, and many earlier ones would also be useful. Copies of NATURE would be particularly acceptable, and some of those who receive this journal regularly may perhaps consider contributing their copies after reading them at leisure. Authors are asked to send reprints of their own papers.

Those who are willing to contribute reprints or copies of NATURE or other journals should send them to me at Burnt Oak, Kidlington, near Oxford. They are asked to give their names, so that they may receive acknowledgements and periodical reports on the progress of the scheme.

No time will be spent on the organization of this scheme which would otherwise be spent on the war effort.

Scientists who are not already sending educational books to British prisoners in enemy hands may care to know that this can be done through the office of the Educational Books Section of the Prisoners of War Department of the British Red Cross Society and Order of St. John of Jerusalem, at the New Bodleian Library, Oxford. This office is kindly keeping in touch with our movement, so that matters of mutual interest may be discussed.

JOHN R. BAKER.

Burnt Oak,
Kidlington,
Near Oxford.

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[1] Baker, J. R., *New Statesman and Nation*, July 18, p. 43.

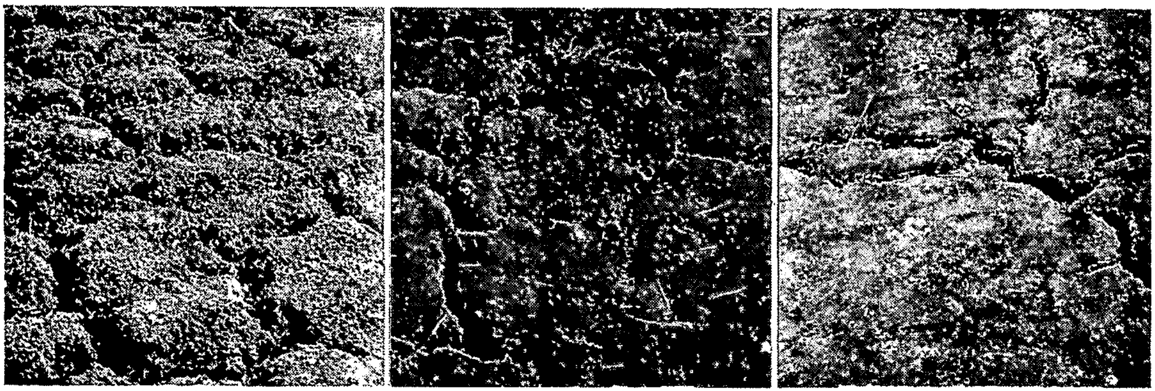
FUNCTION OF SOIL CRACKS

By Dr. A. SREENIVASAN

Institute of Plant Industry, Indore

A CHARACTERISTIC feature of heavy soils such as the black cotton soil is their extensive cracking during summer fallow. Wide fissures are formed as a result of the shrinkage of the soil colloids under the baking action of the hot sun during summer months. These cracks vary from a fraction of an inch to 3–4 in. in width, and are often several feet in depth. It is generally recognized that cracking results in an improvement in the physical properties of the soil, but the factors which determine the character of cracking in field soils have remained rather obscure. Interesting information has been obtained in the course of a survey of the nature and extent of surface cracking in different fields under cotton in the Institute area. The technique adopted was as follows :

The fields were left undisturbed after the last cotton picking towards the end of January. At the hottest part of the year in mid-May, five plots measuring 10 ft. by 10 ft. were marked out at random in each field. Each of these plots was further subdivided into 100 squares, 1 sq. ft. each, and a survey of all the cracks intercepting the lines of these smaller squares mapped on graph-paper. Crack width was measured with a straight edge and, where necessary, by using a pair of dividers. The width was measured along a direction perpendicular to the line of interception with the crack.



Well-drained good field | Well-drained medium field | Badly drained and eroded field

Crack formation in field soils.

The number of cracks of different widths obtained as above in typical fields of known rich, medium and poor fertility are given below (Table 1).

Table 1. Frequency of cracking in different fields.

Width of crack* (in.)	Number of cracks (average per plot)			Remarks	
	Field 7 : Good, well-drained	Field 41*s* : Medium well-drained	Field 27 : Poor, badly drained and eroded	Significance	Critical difference (No. of cracks)
0·5 and less	78·8	16·2	0·4	$P<0{\cdot}01$	18·4
0·5–1·0	60·0	37·4	4·6	$P<0{\cdot}01$	13·5
1·0–1·5	20·2	28·4	31·0	Insig.	—
1·5–2·0	47·6	35·0	23·4	$P<0{\cdot}01$	6·5
2·0–2·5	39·6	37·6	34·0	Insig.	—
2·5–3·0	4·6	4·4	7·2	Insig.	—

* There were few, if any, cracks of width greater than 3·0 in.

Cracking was, on the whole, extensive in the good field, but only meagre in the poor field, the medium field being intermediate in character (see accompanying photographs). The chief difference between the three fields lay in the significantly larger number of small cracks (less than 1·0 in.) in the well-drained fields as compared to the poor field.

An idea of the surface area of cracking was obtained by multiplying the number of individual cracks falling into different width groups (Table 1) by the average width in each instance and summing up these values for each of the three fields :

Table 2. Index of surface area of cracking (average).

Field 7 (good)	Field 41*S* (medium)	Field 27 (poor)	Significance	Critical difference
275·0	225·6	179·6	$P<0{\cdot}01$	34·8

More or less similar results were obtained in surveys carried out over a larger number of fields. It must be emphasized here that these results relate only to fields of the same soil type but differing in their fertility.

No attempt was made to determine the depth of cracking, as it was observed that the fissures leading downward were seldom either vertical or uniform in width. In general, however, the depth to which the cracks extended was often least in fields of low fertility ; in other words, the cracking tended to be superficial in these fields. Furthermore, the soil along the cracks in all the fields possessed a friable structure. But, while the soil in the clods from the good and, to a less extent, medium fields also possessed a loose, friable structure, breaking into smaller crumbs with gentle pressure between the fingers, that from the clods of the waterlogged field was usually hard and broke under pressure with a definite cleavage and a somewhat shining surface.

The loose soil in and around the cracks is subjected to alternate heating and cooling during days and nights over considerable periods of time. Such alternate heating and cooling bring about a state of aggregation[1] which, on account of the differences in the degree of cracking, is obviously more uniform throughout the well-drained fields than in the poor field.

Surface (0–6 in.) and sub-soil (6 in.–12 in.) samples for further laboratory examination were taken by a suitably improvised technique from along the cracks and from inside the clods of the fields of medium and poor fertility. These could not be taken from the rich field as the cracks were too numerous and as, moreover, the soil inside the clods tended to become pulverized readily even under light touch. The results of analyses which will be detailed elsewhere indicated in general that the differences in physical properties between corresponding crack and clod samples were less marked in the well-drained field than in the eroded field. With the latter, there was greater uniformity between surface and sub-soil samples taken along the cracks than from the clods. Thus, the main contrast between the well-drained and poorly drained fields was in the depth to which good tilth existed below the surface.

These observations could be explained as principally due to the fact that, by means of these cracks, considerable quantities of soil material are periodically carried down from the surface to lower depths within the soil, both on account of the hot summer winds and by the early June rains[2]. It is also probable that the first showers of the monsoon are followed by the swelling up of the colloidal masses from below[3]. There is thus a pronounced circulation of the soil material, a result similar to that brought about by cultivation. This 'self-ploughing and sub-soiling'[4] is so intense that mechanical cultivation often becomes ineffective. Experiments carried out for more than five years at this Institute[5] have shown conclusively that summer cultivation with or without inversion to different depths before *Kharif* sowing is not necessary for the rain-sown, unmanured cotton crop. It has been shown similarly that preparatory cultivation on the black soils of Koilpatti (S. India)[6] and in the Sudan[7] is superfluous and may, at times, be decidedly harmful[8]. Even in temperate and cooler regions the effect of the traditional thorough cultivation has begun to be doubted. Thus, at Rothamsted[9], it has been shown that cultivation in excess of that needed to keep down the worst weeds does not confer any further benefit and may even result in a reduction in yield. It would, of course, be useful to adopt summer ploughing in a weed-infested field such as, for example, in the eradication of *kans* (*Saccharam spontaneum*) and *dhub* (*Cyanadon dactylon*), for it is found that hot-weather ploughing exposes and kills the roots[10].

An interesting observation was that the concentration of soluble salts in the soil along the cracks was always higher than in the corresponding sample from the clods (*cf.* Mosseri)[11]. This would suggest the possibility of reclaiming saline lands by promoting crack formation, which will be followed by the washing down with the first rains of the deleterious salts along the crack edges.

Another significant observation related to the rather wide difference in the swelling capacity of the surface and sub-soil samples taken along the cracks, this difference being somewhat less pronounced in the poor field. In either field, the samples from clods did not show any appreciable difference in this property. It would appear that the greater difference with depth in this respect may account for the higher degree of cracking in the well-drained field.

It may be concluded from the foregoing that the development of soil cracks during summer fallow must be promoted. This can be done (i) as already stated, by avoiding, or at any rate reducing to a minimum, cultivation during summer fallow, and (ii) by allowing crop plants to remain in the fields for a certain period (say, until about the beginning of May) after harvesting operations are over. In the latter case, the standing plants will tend to put out ratoon growths. This will be accompanied by deeper penetration of roots followed by new lines of cracking. I have observed that the juxtaposition of crop rows with field cracks have confirmed that standing crops greatly facilitate soil cracking. A possible objection to this practice is that the ratoon crop may deplete the soil of its fertility; while this may be true in some measure, it should be pointed out that if the standing crop is removed by about the middle of the hot season, the recuperative power of the soil during the hot period, coupled with the advantages of better cracking, may offset this depletion. If, however, such crops have had, during their normal period of growth, any disease or insect attack, it may be necessary to pull them out as soon as harvest is over.

It is of interest to compare here the beneficial effects on crop growth resulting from (1) building up of the loose surface soil artificially to different thicknesses[12], and (2) application of 'fired' soil in the sub-surface regions[7, 13]. In heavy soils, the wide cracks formed as a result of extreme variations in swelling and shrinkage is indeed Nature's efficient method of heating and weathering the sub-soil layers. This uniformity with depth in the surface soil will obviously promote greater bacterial activity with consequent production of mucus, which aids in the formation of water-stable aggregates [14, 15].

The advantages of cracking during any one season will admittedly be small, but the cumulative effect over prolonged periods will no doubt be appreciable enough to increase the fertility of a field. Besides, in a waterlogged field, the development of these cracks, followed by the ingress of the surface soil through them, will improve the permeability and drainage conditions in the field.

[1] Bouyoucos, G. J., *Soil Sci.*, **18**, 103 (1924).

[2] Greene, H., *J. Agric. Sci.*, **18**, 518 (1928).

[3] Vageler, P., "An Introduction to Tropical Soils" (London: Macmillan, 1933), p. 179.

[4] Howard, A., "An Agricultural Testament" (Oxford, Univ. Press, 1940), p. 138.

[5] Annual Report, Institute of Plant Industry, Indore (1937).

[6] Ayyar, V. R., Ayyar, S. S., and Tirumalachari, N. C., *Madras Agric. J.*, **28**, 69 (1940).

[7] Annual Report, Gezira Agric. Res. Ser., Sudan Govt. (1937).

[8] Viswa Nath, B., *Agric. and Live-stock in India*, **8**, 9 (1938).

[9] Russell, E. W., and Keen, B. A., *J. Agric. Sci.*, **28**, 212 (1938); Keen, B. A., *J. Min. Agric.*, **45**, 645 (1938).

[10] Howard, A., *Agric. J. Ind.*, **22**, 39 (1927).

[11] Cited from Keen, B. A., "The Physical Properties of the Soil" (London, Longmans, 1931), p. 144.

[12] Sreenivasan, A., NATURE, **148**, 144 (1941).

[13] Sreenivasan, A., and Aurangabadkar, R. K., *Soil Sci.*, **50**, 449 (1940).

[14] Peele, T. C., *J. Amer. Soc. Agron.*, **32**, 204 (1940).

[15] Martin, J. P., and Waksman, S. A., *Soil Sci.*, **52**, 381 (1941).

REBUILDING GREAT BRITAIN

THE Reconstruction Committee of the Royal Institute of British Architects, which has already published five interim reports dealing with planning and amenities, war-time housing, building legislation, reconstruction of the architectural profession and legislation affecting town and country planning in Great Britain, has now issued a first general statement of conclusions, which in some respects provides an interesting parallel to the recent report of the Scott committee.

Dealing first with human needs as a foundation for reconstruction, the statement points out that from the point of view of physical reconstruction, the essential needs of the individual are suitable work in clean, healthy and cheerful surroundings and a convenient and attractive home, forming part of a community capable of evoking local patriotism and civic pride. The most essential public needs for physical reconstruction are a firmly established agriculture, a prosperous, well-located industry, and an efficient system of transport. As regards the practical and æsthetic needs, the public is right in expecting and demanding that the opportunity afforded by post-war reconstruction shall not be thrown away; buildings and towns must be both convenient for use and pleasant to live in. A civic sense has been slowly but firmly growing up in the people, one form of which is seen in the demand that the slum areas should be no longer tolerated and in regarding the effect of war damage in these areas as an opportunity for total reconstruction. In another form it is seen in the determination to check ribbon development, because that constitutes an offence to the eye, and also in the positive demand that cities and towns should be better to look at and better planned.

In outlining a national plan to meet these needs, the statement points out that assurance is required that the Government's positive policy will deal with individual as well as public needs, and this must be demonstrated by the creation of machinery to produce a national plan as well as to execute it, by the creation of the plan and by its execution. Of these four positive acts the last cannot be contemplated until after the War, but the difficulties in undertaking the other three in war-time must be overcome, at least to the extent of producing the general lines of each before the end of hostilities.

With regard to the machinery of planning, the statement points out that a national authority is essential to obtain a national plan, and at least four Government departments will be deeply involved. Unless all the departments concerned are amalgamated into one huge department, the national planning authority must be so devised that it has the power to co-ordinate the proposals of the various departments and to over-rule the views of any single department when necessary for the sake of the plan as a whole. Some parts at least of the plan will be such that neither private enterprise nor local authority will be able to execute them, and a central executive body will be required to ensure the execution of such work. Accordingly, in addition to a national planning authority and a national planning commission, a development commission will also be required. This commission should be made responsible for ensuring the smooth working of the plan in all developments, whether executed by itself, by Government departments, by local authorities or by private enterprise. It would also be responsible for providing local authorities and public utility companies with the necessary credit for the execution of local schemes. In this connexion attention is directed to the Tennessee Valley Authority as a precedent for public development.

In regard to planning authorities, the organization of the whole would presumably consist of a central planning national authority with its regional officers, and groups of local authorities to prepare the local or sub-regional schemes.

A national code of legislation should be compiled to cover the whole of Great Britain, administered from a single office in each locality. This national code should be in three parts, the first dealing with planning for human needs, or what might be termed a code of living standards. The second would deal with structural standards and the third with the financial provisions which will be necessary to achieve these ends.

It is suggested that the code of living standards might be in two parts dealing respectively with standards of amenity which might be advisory, not compulsory, and with health and safety precautions, which should be mandatory. Under this national code, only one application should be necessary for the approval of plans, but submission of plans for approval should be compulsory for all types of buildings. In addition, the appointment of a national building board is visualized, as outlined in a previous interim report.

In regard to the organization of the building industry, co-ordination of the main groups of the industry, the employers, the operatives, professional bodies and the manufacturers and distributors of building materials can best be achieved through the machinery of a central council which might form a liaison with Government departments. So far as technique is concerned, it is essential that those adopted should provide good building with the utmost possible economy as well as the maximum output, and a proper balance between first cost and cost of maintenance.

Surveys already carried out by the Committee indicate that public control of the building industry must continue after the War, and the techniques adopted in building will affect and be affected by the public policy on imports, transport, etc. Coupled with centralized control, the Committee therefore strongly recommends centralized research, expanded and made independent of outside donations by a sufficient Treasury grant. This centralized research should be under the charge of the Building Research Organization.

In regard to finance, the Committee urges that in drawing up its plans for reconstruction, the Government should relieve local authorities of regions of the financial burden, simplify the machinery for dealing with private interests which may be affected, and arrange for the dispatch and distribution of the resources of the building industry in whatever manner seems best for the national interest. With regard to filling in the plan, it is suggested that all land without exception should be publicly controlled, whether publicly or privately owned.

The great building programmes will be so profoundly affected by any changes in the location of industry that local authorities will only be able to make tentative estimates of their needs until Government policy on this subject is formulated. In the existing large towns or 'conurbations', the need for the centralization is generally agreed, and building of a certain number of new satellite towns is complementary to this decentralization. Regrouping within the boundaries of existing towns is as important as decentralization, and new towns should, when possible, be developed from existing small towns or villages.

A local improvement fund for each district is recommended and a very close relation should exist between the housing and town planning committees in an area. Housing should form part of a well-conceived plan for re-equipping the country, and in that it should incorporate standards fulfilling the desires and requirements of the population, should be able to call for the best technical advice and knowledge available. The selection of suitable architects requires careful attention. The post-war housing needs cannot be estimated, but the position facing the building industry must be handled on a national, not a local, scale, and only by careful planning ahead can the post-war housing needs be met. The emergency and the long-term programmes must fit into a national scheme which takes account of the future redistribution of industry and of methods of construction. There is no suggestion that the provision of housing by private builders should be discouraged, provided excessive profits on land and buildings are eliminated and that standards both in design and construction are reasonably good. A national policy for house production should be formulated to co-ordinate the work of the various house-building agencies and constitute more even distribution of work and results. Research into consumer needs should also be encouraged.

The final section of the statement deals with the importance of the architect's contribution, both in modern planning and in the public control of the appearance of buildings, and it is stressed that it is essential that every planning authority should employ a well-qualified architect as a principal officer directly responsible to that authority.

LEAD-CALCIUM TEST CASTINGS

CLOSE control of the calcium content is required in the manufacture of lead-calcium cable sheath. This is not easily attainable because the calcium content is small and a variable amount is lost while the alloy is molten, despite the special techniques used to minimize air contact. Conventional methods of determining this loss are slow and costly. A new procedure described by G. M. Bouton (*Bell Lab. Rec.*, 20, No. 10; June, 1942) arises from Bell Laboratory studies of lead-calcium alloys which have shown that the surfaces of ingots, chill cast with little agitation, become progressively duller with increasing calcium content. Fissuring then sets in and leaves bright areas exposed, depending in extent on the amount of calcium present. Under controlled conditions these markings provide a quick, accurate measurement of the calcium content.

The sample is melted in a small iron crucible, the lip of which is brought close to the mould before pouring, to minimize exposure to the atmosphere. The mould itself is an iron plate with a tapered depression about 4 in. long and $\frac{5}{8}$ in. wide, milled on its surface. To ensure reproducible results, casting is done in a 'Cellophane' chamber through which passes air of known carbon dioxide and moisture content. Since both affect the results, they are first removed by passing the air over potassium hydroxide and calcium chloride. A definite percentage of each is then replaced in the casting chamber, and the melt poured. Representative figures are 50 per cent. humidity and 0·02 per cent carbon dioxide. Decreasing moisture and increasing carbon dioxide make the surface brighter, and vice versa. Alloys of calcium content outside the range of the method may be tested by diluting or enriching them with lead-calcium alloys containing appropriate amounts of calcium. This method of determining the calcium content in cable sheath is reliable and more rapid than chemical analysis or metallographic techniques.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Saturday, October 3

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. David Williams: "Mineral Resources of the U.S.S.R".

Tuesday, October 6

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Sir Leonard Hill, F.R.S.: "The Interrelation of Clothing and Shortage of Fuel in matters of Health".*

Friday, October 9

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. E. Watson Smyth: "The Training Activities of the Ministry of Labour".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF ENGINEERING DEPARTMENT (MECHANICAL AND ELECTRICAL) in the School of Mines and Technology, Treforest—The Director of Education, Glamorgan County Hall, Cardiff (October 12).

LECTURER IN ELECTRICAL ENGINEERING—The Secretary, University College, Dundee.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of the Committee on Amenities and Welfare Conditions in the Three Women's Services. (Cmd. 6384.) Pp. 58. (London: H.M. Stationery Office.) 1*s*. net. [149

Proceedings of the Royal Irish Academy. Vol. 48, Section A, No. 1: The Band Spectrum of Manganese Hydride, MnH, 1: Structure of the λ5677 and λ6237 Bands. By T. E. Nevin. Pp. 42+3 plates. 3*s*. Vol. 48, Section A, No. 2: The Energy of the $1s2s\,^3S$ State of the Helium Atom and related Two-Electron Ions. By T. S. Wheeler. Pp. 43–53. 1*s*. Vol. 48, Section B, No. 3: The Albite-Schists of Antrim and their Petrogenetic Relationship to Caledonian Orogenesis. By Doris L. Reynolds. Pp. 43–66. 1*s*. 6*d*. Vol. 48, Section B, No. 4: River Liffey Survey, 5: Growth of Brown Trout (*Salmo trutta* L.) in Alkaline and Acid Waters. By Arthur E. J. Went and Winifred E. Frost. Pp. 67–84. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [229

Other Countries

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 23, No. 33: Redescription of Three Species of the Polychætous Family Polynoidæ from California. By Tage Skogsberg. Pp. 481–502 +plate 43. (San Francisco, Calif.: California Academy of Sciences.) [149

Reports of the Great Barrier Reef Committee. Vol. 5. Pp. iv+122+9 plates. (Brisbane: Great Barrier Reef Committee.) 10*s*. [179

Indian Association for the Cultivation of Science. Annual Report for the Year 1941. Pp. 38. (Calcutta: Indian Association for the Cultivation of Science.) [189

Indian Forest Bulletin No. 110 (Utilisation, New Series): A Short Note on Wood Preservation for Users in India. By Dr. D. Narayanamurti. Pp. v+22+5 plates. (Delhi: Manager of Publications.) 12 annas; 1*s*. [189

Memoirs of the Geological Survey of India. Palæontologia Indica, New Series, Vol. 30, Memoir No. 2: Some Permian Corals from the Plateau Limestone of the Southern Shan States, Burma. By Dr. Stanley Smith. Pp. iii+24+2 plates. (Calcutta: Geological Survey of India.) 1.8 rupees; 2*s*. 3*d*. [189

Forest Research Institute, Dehra Dun. Indian Forest Leaflet No. 13: Safe Working Stresses for some Important Indian Timbers. By V. D. Limaye. Pp. ii+11. Indian Forest Leaflet No. 14: A Preliminary Note on the Suitability of Indian Woods for Battery Separators. By M. A. Rehman and S. M. Ishaq. Pp. iii+4. Indian Forest Leaflet No. 15: Studies on Adhesives, Part 1: Ground-Nut Protein Adhesives for Plywood. By D. Narayanamurti, V. Ranganathan and P. K. Basu Roy Chaudhuri. Pp. ii+9. Indian Forest Leaflet No. 16: Studies on Adhesives, Part 2: Ground-Nut Protein-Formaldehyde Dispersions as Plywood Adhesives. By D. Narayanamurti and Kartar Singh. Pp. ii+13. Indian Forest Leaflet No. 17: Interim Report on the Suitability of some Indian Species for Aircraft Construction—*Michelia* species (*champ*). By V. D. Limaye. Pp. ii+3. 4 annas; 6*d*. Indian Forest Leaflet No. 20: A Note on *Derris* and other Rotenone Bearing Vegetable Insecticides, their Occurrence and Possibilities of Cultivation in India. By T. P. Ghose. Pp. ii+9. 4 annas; 6*d*. (Dehra Dun: Forest Research Institute.) [189

Bulletin of the American Museum of Natural History. Vol. 80, Art. 1; Results of the Archbold Expeditions, No. 45: Mammal Notes from Highland County, Florida. By A. L. Rand and Per Host. Pp. 21. (New York: American Museum of Natural History.) [229

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PHYSICS
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NUTRITIONAL RESEARCH

THE field of nutrition tends daily to enlarge. It has already established itself over considerable areas long considered to be exclusively the domain of medicine and concerned with the problem of curing and preventing disease. It has invaded chemical engineering; for example, it now requires plant for large-scale dehydration of foods with minimum destruction of essential nutrients. In its urgent need for precise analytical data about the composition of foods and diets, it has needed to mobilize not only the analytical chemist, but also the bio-assayist—with the statistician in close attendance—the physical chemist and physicist, with a special call on those having experience in X-ray crystallography, in spectroscopy, both visual and ultra-violet, and most recently in polarography; this is one of the latest techniques to be added to the many, such as chromatography, that have stimulated and been stimulated by our increasing knowledge about the nutrients present in what we and our domestic animals eat.

When it comes to applying in practice what has been learnt in laboratory, in field and in hospital ward, and applying it to the largest possible number of people over the largest possible areas of the world, others with expert knowledge are needed to add their counsel to that of the scientific investigator and the practising physician. The anthropologist, the educationist, the sociologist, the geneticist, the economist, among many, are able to contribute data of value to those who wish to direct the maximum quantity of the best foods to the places where the people most need it, and to secure that the people who most need it are persuaded to eat it, and can afford to do so—to eat it, moreover, before any appreciable proportion of its essential nutrients has been lost.

That the problems embraced under the general terms 'nutritional research' and 'food policy' are many, complex and interlocked is a fact of which increasing numbers of people—and not least the workers in nutrition themselves—are becoming aware. This awareness is doubtless largely responsible for the foundation of the Nutrition Society in August 1941, and the great success of its meetings held since then in England and Scotland and reported from time to time in NATURE. At these meetings there has been free interchange of information and opinion between a great variety of specialists, all, however, legitimately sheltering under cover of the nutritional umbrella. In particular, the contact between clinicians and veterinarians at these meetings has been a matter of favourable comment.

The same awareness is presumably responsible for the interest shown by the writers of letters to *The Times* on the proposal for a Nutrition Council put forward in its columns on August 28, and since then supported by the *British Medical Journal* in its issue of September 26. On the whole, the proposal has been received with favour, but certain distinguished physicians have argued that the Medical Research Council is in effect, or should be, a Nutrition Council and that to set up yet another co-ordinating body would be unjustifiable, especially in war-time, because unnecessary.' It has also been suggested that the Nutrition Society itself could exercise the required functions. These comments, and the original proposal for setting up a new *ad hoc* Nutrition Council, its structure and powers, obviously call for close examination.

First of all, the part to be played by the Nutrition Society can easily be defined. It is a scientific society—a 'learned' society, indeed, although it confers no diplomas or post-nominal initials—and seeks to promote, among those who experiment and observe, the dissemination of knowledge about nutrition gained through experiment and observation. It is not concerned with educating the public or its representatives, at one end of the scientific scale, or with planning research, at the other. It is no more, and no less, suited to become a Nutrition Council than, say, a joint committee of the Chemical and the Physical Societies would be suited to become the Department of Scientific and Industrial Research. This is, of course, not to deny for one moment that the personnel of a Nutrition Council must include members, even perhaps representatives, of the Nutrition Society.

It has been ingeniously argued by Lord Dawson of Penn that the Medical Research Council's recent appointment of Prof. C. R. Harington as director of the National Institute of Medical Research, in succession to Sir Henry Dale, should so clearly show its awareness of the essential part played by non-medical sciences in medical research as to overcome all scruples about leaving nutrition research in the hands of the Council. Lord Dawson has also directed attention to the many branches of science that have been mobilized to attack the diverse problems with which the Medical Research Council has been for some years concerned, and to the fact that a high proportion of its own staff is not medically qualified. This, he contends, proves not only that the Council is aware of the need for collaboration between medical and non-medical men of science, but also that its ability in the past to co-ordinate their activities, and the brilliant conclusions to which they have jointly been able to bring so many and so varied investigations, proves its fitness to be what, in fact, it is—a Nutrition Council.

We suggest that this misses the point of those who argue in favour of a controlling body representative of sciences other than the purely medical, along, of course, with full and probably preponderating representation of all the relevant specialized branches of medicine itself. This is a view to which Lord Horder and Sir Charles Wilson would seem to subscribe. It is based upon the simple principle that those who are to play an essential part in elucidating scientific problems should be entitled to share in decisions as to what problems are to be tackled and how. If the biochemist, the analyst, the food technologist, and many others to whom we have referred already, are essential to the increasing elucidation of nutritional facts and principles, then surely a Nutrition Council must include representatives of chemistry, agriculture and engineering, as also obviously of physiology, pharmacology, biology, statistics and so on, irrespective of whether they are medically qualified or not. Medical men must, in any event, be there also in full force, by virtue of their dominating and central interest in the bearing of nutrition upon health, but a Nutrition Council constituted *ad hoc* would attack—if it functioned aright—its problems from the point of view of human and animal nutrition and feeding, and not from the point of view of medicine only.

It is perhaps of interest to note that the opinion held by Lord Dawson—and also by Sir Francis Fremantle—that it would be satisfactory to leave the direction of nutritional research as a whole in the hands of a purely medical body, has not been put forward in public by any medical men who have been directly engaged on, or especially interested in, nutritional problems. Such medically qualified workers seem in general strongly to favour joint action and equal status with their non-medical scientific colleagues. It is, further, we feel convinced, not a view to which the Department of Scientific and Industrial Research, which controls the work of the Food Investigation Board, could possibly subscribe, nor yet the Agricultural Research Council. Further, if nutritional research is to be controlled by a body that is primarily medical, has not the Ministry of Health as much claim to be that body as has the Medical Research Council ? Finally, since the object of nutritional research is to find out what are desirable foods and to investigate means of producing them, the Ministry of Food, with its now highly effective and far-seeing scientific staff, must come into the picture.

The more the problem is examined, the stronger appears the case for a new body, linking up with all those organizations and departments that have any concern with nutrition and food problems—but in no way interfering with their legitimate autonomy—acting primarily as a centre of information about the results of past research and the nature of research in progress and to an ever-increasing degree guiding, without actually dictating, the direction of new investigations. Such a body, if constituted as a Nutrition Council, might, like the three existing research councils, be a committee of the Privy Council; alternatively, as has been suggested by the Association of Scientific Workers, it might be one of the main committees of a Central Scientific and Technical Board. This question, however, though obviously of importance, is at the moment of secondary interest. We are much more concerned with ensuring on the nutritional front a far greater degree of genuine active collaboration than there is reason to believe now exists between the Medical Research Council, the Ministries of Agriculture, of Health, of Food, and of Labour and National Service, the Board of Education, the Department of Scientific and Industrial Research, the three Service Departments and the considerable array of industrial laboratories (including Research Associations) that are engaged in one way or another in investigating problems with a direct or indirect bearing on nutrition.

It cannot seriously be maintained that co-ordination, even co-ordination of existing knowledge about methods and results, is at present adequate between the large number of laboratories, hospitals and experimental farms in Great Britain involved in nutritional studies in the widest sense. There are many actual and potential workers in this field who would enthusiastically welcome some recognized centre to which they could turn for advice about what to do next and how to do it, in the best interests of the nation at war. At meetings of scientific societies it happens over and over again that workers discover others to be investigating problems allied to, or even the same as, those on which they have themselves been working, independently and, as they thought, solely. How much better had contact been made before the work was well in hand.

We have suggested above that co-ordination, if it is to be effective, must include several major State Departments, besides the organizations specifically devoted to research, both outside and inside industry. This appears to be generally recognized, but it has led to a confusion of thought that, if not removed, might have unpleasant or even disastrous consequences. It is a fundamental principle in a country organized as a parliamentary democracy that all questions of major policy, affecting the everyday life and health of the people, must be decided by that people, speaking and acting through its constitutionally elected representatives, the Government and the Cabinet. Nor can there be the slightest doubt that decisions about the people's food, what it shall be, how it shall be distributed and what it shall cost in terms of real wages, are decisions on a matter of major policy. It follows inevitably that food policy must be determined by Parliament. To suggest that an *ad hoc* organization of experts shall make decisions on such matters of policy is not merely to propose a restriction on the legitimate rights of the ordinary citizen, but also to condone the introduction of the thin end of the wedge of the totalitarian State. It must be vigorously opposed by all men of democratic goodwill, no less by those who support the formation of a new Nutrition Council than by those who oppose it. The fundamental business of such a Council would be to bring together existing knowledge and disseminate it properly, to co-ordinate present investigations, and to map out future research. Under the first of these heads, it may be remarked, one of the most important tasks is to forward that knowledge directly to those who have to control, on behalf of the community, the country's food policy. General educational propaganda can probably best be left to other bodies, especially to those more closely linked with local government activities, a procedure that is rapidly extending in both Canada and the United States. One letter in *The Times* argues that the suggested work of a Nutrition Council is the function of the Cabinet's Committee on Food Policy. Surely this is but a further instance of the confusion to which we have just referred—quite apart from the fact that this Committee is concerned with transmitting advice and information only in one direction, upwards, and has no part to play in the organization of actual research.

Thus, decisions on food policy are, as Sir John Orr has also emphasized, matters for Parliament and the Government. The Nutrition Council as such should have nothing to do directly with food policy, but indirectly it could vitally affect policy. Its task would be, by its contact with responsible Ministers and administrators, to make available to them as rapidly as possible those established results of nutritional research on which, and on which alone, a wise and lasting policy, one that makes for health in the national sphere and peace in the international sphere, must be based. The conditions of war, despite all its handicaps and horrors, make advances in nutritional knowledge more rapid in many directions even than those that have characterized the last three decades or so. The potentialities can only be exploited to the full if all available knowledge and skill, from many scientific disciplines, can be brought to bear with speed and efficiency. A properly constituted Nutrition Council would be a valuable, and may be an indispensable, means to this end.

EDUCATION AND LEADERSHIP IN THE WOMEN'S SERVICES

THE report of the Committee on Amenities and Welfare Conditions in the Three Women's Services* merits wide publicity. A thorough and searching inquiry provides the basis for a balanced and reassuring report which effectively disposes of the vague and sweeping charges of immorality. Some unpleasant experiences in the Services are frankly acknowledged, and the report shows no lack of constructive criticism or, on the other hand, of appreciation for what is and always has been good in the three Services.

Healthy realism and common sense pervade the report, which does not conceal the fact that mistakes in administration have been made, and that the biggest problem in the Women's Services, as elsewhere, is not that arising out of hardships or rough conditions, which are instinctively recognized as part and parcel of the War, but out of boredom in the non-operational units. There lies the main danger to morale both in the Services or in the civil population, and it is of the utmost importance that due attention should be given to this question at an early stage.

Taking the view that the essentials for welfare are definite minimum standards of accommodation, warmth, food, medical attention and hygiene; good leadership by efficient and understanding officers; full utilization of individual capacity so far as the exigencies of the Services permit; and encouragement from home and from the general public, the Committee, while not minimizing the part which the Services have to play, shows unmistakably that the public must bear some responsibility itself in this matter of welfare. The part which the officer can play is rightly stressed. An officer whose first care is her platoon or company can, by her zeal, unselfishness and good sense, make the roughest conditions acceptable, while if an officer is indifferent or unsympathetic, the tone deteriorates and complaints mount up even in the best and most modern of accommodation.

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* Report of the Committee on Amenities and Welfare Conditions in the Three Women's Services. (Cmd. 6384.) Pp. 58. (London: H.M. Stationery Office, 1942.) 1s. net.

With much of the detail of this report scientific workers have little direct concern, though the sanity and foresight of many of its comments, for example, in regard to cooking and the raising of standards, and the recruitment of officers, are of at least passing interest, but the invigorating vision of opportunity which characterizes the sections of the report dealing with education and with the future gives these sections at least outstanding claims on their attention. The Committee frankly recognizes that the major problem which lies ahead of society is how to reconcile in a highly mechanized world the quality and free expression of the individual within the framework of the co-operative State. The middle path has to be found along which organization and individuality can walk together hand in hand, and though the Committee recognizes that in the three Services young women have been brought together, without distinction of class, to share a common life while fulfilling a common duty to their country, it is felt that a great opportunity is being missed in another direction. Service life with its common tasks, common duties and common amusements is a training place in the subordination of the individual to the whole; but the whole can have no richness unless interpenetrated by the quality and variety of the individual human beings who compose it.

The mingling of all classes in the present national effort is unquestionably a situation full of promise for the future, and from this point of view the camps represent a great social experiment no less than a great military effort. Experiences previously unknown on one side or the other have been exchanged and shared. Camp life, too, is a great discipline in give and take, and in sharing the ups and downs of a common existence. From the soil thus ploughed a rich harvest may be gathered if the seed is first sown by a wise and skilful sower.

This is the point of view from which the Committee approaches the question of education, and while it is clear that so far as facilities and organization are concerned, the authorities provide generously for any educational demand made on them by the men and women of the Services, it is idle to pretend that the demand is in any respect equal to the possible supply. Education as a great adventure, as an adventure which makes life infinitely more attractive and exciting, is an appeal which falls too often on uncomprehending ears. It is a melancholy reflection, the report observes, on the educational failures of the last twenty-five years, that many young people refuse to use their minds at all outside working hours, and their only cry is for amusement which can be produced without any demand on their initiative, industry or intelligence.

The Committee considers that youth cannot be held responsible for this dangerous and disturbing position, which the difficulties of Service education in the present War have thrown into high relief. In pre-war days, leadership failed a young people who still depend more than they realize on the outlook of their elders, and who were left by the latter without any heroic appeal either to their imagination or sense of duty. We owe them what compensation in us lies for the state of the world as it is to-day, and the Committee refuses to acquiesce in a defeatist attitude about a matter so intimately concerned with the great issues of the present and future. A number of proposals for stimulating interest are made, the main recommendation being the appointment of an adequate number of women of suitable rank and relevant experience as education officers in the field to ascertain the outlook and requirements of the rank and file and to stimulate interest among the officers of the Women's Forces. It is recommended further that the curricula of the officers' training courses and of refresher courses should be placed on a broader basis; that the Army Bureau of Current Affairs scheme should be invariably applied in the A.T.S. and should be extended to the W.A.A.F. and the W.R.N.S.; that crafts should be encouraged for those whose tastes lie in practical directions, and that the Council for the Encouragement of Music and the Arts should be asked to co-operate in the general development of music, drama and the arts.

These recommendations are clearly to be justified on the ground of their immediate contribution to the morale and efficiency of the Women's Services. Their bearing on the welfare of the young womanhood of Great Britain after the War and on the future of the Women's Services, so brilliantly discussed in the concluding section of the report, is no less obvious. The unparalleled opportunity of education in citizenship and good living is recognized. There are things to unlearn and false idols to dethrone, but the chance if seized may sweep the whole national existence from banks and shallows into the great waters of the main.

Whether we look to this educational aspect or to the new riches which the country has found in this great development of skilled capacity in the Women's Services and elsewhere through the War, the question of the future of the Women's Services cannot but be considered. That indeed lay outside the terms of reference of the Markham Committee, though it is clear that the uncertainty is affecting the recruiting of young women of the professional classes. Moreover, no thoughtful observer can be blind to the waste which would be involved in any immediate break up of the Women's Services and the abrupt termination of their remarkable contribution when the cease fire sounds. Effort and sacrifice no less than time and worry went to their creation. Their efficiency increases daily, and it is only right that the question whether the State has no use for them after the War should be frankly faced.

Demobilization of a nation in arms and remobilization for the campaigns of peace should clearly, when the time comes, take place with due regard both to the tasks ahead and the personnel available. The Markham Committee is convinced that in the Women's Services the nation possesses an instrument of great potential usefulness, and suggests that when their present duties come to an end, their training and experience make them specially fitted for service in the field of European reconstruction. Detachments of the Women's Services would, they consider, be admirably fitted to share in the duties of the technical staffs which will be required throughout Europe, both for administration and relief, to meet the needs of the liberated populations. The various missions concerned with food and clothing, housing and medical assistance, which must clearly function as a first step on the Continent, for a time can obviously only function on a military basis and under the protection of the armed forces engaged in the restoration of order. Much of the work to be done is, moreover, work in which the co-operation of women is not only desirable but also essential, and that co-operation could be achieved rapidly and simply through the organization of the auxiliaries for foreign service.

Besides such specific duties as those of clerks, cooks, drivers and orderlies, there will be plenty of administrative tasks for officers capable of handling the problems of want and suffering which the liberated countries will present. While, however, employment for the time being on the Continent—for which, as the report notes, a precedent already exists—would ease the demobilization of the Women's Services and the return of its personnel to civil life, the Committee considers that the moral effect of this proposal is far more important than any other consideration. "To associate women with the task of reconstruction in Europe, to call upon them to share in a work of healing and mercy, would be not only to bring their war duties to a noble conclusion but to open a new chapter in international relationships of high value for the future."

There can be little doubt that volunteers would be forthcoming from all the Services for any feasible scheme on these lines, and that the auxiliaries would throw themselves into the work and adventure of peace with the same enthusiasm as they show to-day in the work and adventure of war. Knowledge and experience gained in this way could scarcely fail to be of value to themselves and others in remodelling a world in which all are groping towards some practical expression of the truth that we are members one of another, united by ties of past suffering and a larger hope for the future. There is wisdom as well as vision in these suggestions of the report, and they have their own special implications for all who are concerned with the wide problems of reconstruction, among which that of education adequate to meet the needs of a new world is one of the foremost and most urgent.

AUSTERITY THINKING

Sumner To-day

Selected Essays of William Graham Sumner, with Comments by American Leaders. Edited by Prof. Maurice R. Davie. Pp. xxvi+194. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1940.) 15*s*. 6*d*. net.

THE name of William Graham Sumner (1840–1910) is so comparatively little known in Great Britain, except perhaps as the author of "Folkways", that it comes as something of a surprise to discover that there is in the United States a Sumner Club which has sponsored the publication of this centenary volume "as a means for stimulating the scientific study of society". The book itself consists of reprints of some of Sumner's essays, lectures, and extracts from his works together with comments by so-called "American leaders".

The essays have as a whole an astringent flavour and are the more challenging as coming from the pen of one who was mistrustful of democracy in its hey-day, and a robust champion of the individualist point of view, a "hard-headed realist" as he has been called by a recent writer, "the father of all the debunkers". He tilts at what he considers the "absurd effort to make the world over", contending that the social order is fixed by laws of Nature which men must in the long run obey, their only hope of better and happier living lying in greater industry, self-denial and temperance. There is no short-cut to prosperity and no way by which men can be saved from the consequences of their own failure. He was disdainful of much of the teaching of his day: robust in his repudiation of many fashionable doctrines, and insistent above all on the necessity for dispassionate examination of social issues and problems and the separation of the scientific and emotional attitudes to these problems.

We have only recently entered upon a period in which it is possible for the sociologist to be educated as such, and Sumner went to Europe as a young man to study for the Christian ministry. From the Germans he apparently learned much through what he calls their "nobly scientific" approach to the study of the Bible. But at Oxford he gained more from his fellow students than from his teachers, and acquired such a taste for social and political inquiry that three years after his ordination in 1869 he was actually appointed to the chair of political and social science at Yale. There he wielded considerable influence, interesting his students in social study, taking over the Spencerian doctrine of social forces and social laws, and preaching the necessity both for studying and conforming to them. The word 'preaching' is used advisedly; for Sumner was nothing if not dogmatic, and (despite himself) as much moralist as scientist. There is little doubt, however, that he served a useful function in his day, shaking men out of their complacency, demanding careful scrutiny of measures proposed for the betterment of human affairs; pessimistic perhaps as to their consummation, but anxious only to know the truth—in the belief that the truth alone, however unpalatable, could set men free.

To Sumner, if the notion of equality was suspect, liberty as interpreted at the end of last century was no less so, and justice not by any means to be achieved along the lines of the panacea so frequently advocated —that of a fresh transfer of wealth from one section of the community to another. His plea for "The Forgotten Man", for example, is made in favour of the uncomplaining millions, the victims as he calls them of the reformer, the social speculator and the philanthropist—the small men of the lower middle class to whose misfortunes attention is seldom given, and who are called on from their meagre living to share the burden of the support of the socially inadequate. In a free democracy all propositions to do something for the working classes have, we are told, an air of patronage and superiority which are out of place; the capital needed for the support of social failures is inevitably diverted from alternative and better uses, and liberty must take the form of industrial competition.

Enough has perhaps been said to show the general tenor of the ideas set out in the papers collected in this book. The comments which follow them are brief, very variable in quality and character, and chiefly interesting as emphasizing the dual nature of Sumner's teaching: its 'timeliness' in the broader sense, its 'out-of-dateness' in many cases in the narrower. But when all is said and done the essays are still provocative and challenging and raise anew certain questions much in the minds of thinking men at the present time: how can we in fact embark upon a study of society that shall be truly scientific, for example, and to what extent can social planning be finally divorced from a consideration of the values involved? "The fashion of forming ideals", says Sumner severely, "corrupts the mind and injures character. What we need to practise, on the contrary, is to know with the greatest exactitude what is and then plan to deal with the case as it is by the most approved means." He demanded, in short, of the young men to whom he addressed the paper from which the above quotation is taken, an exercise in strict intellectual discipline which might well be emulated at a time when the practice of austerity in other fields has become for once both necessary and fashionable. E. I. Black.

BLUEPRINTS FOR A NEW SCIENCE

Foundations for a Science of Personality

By Dr. Andras Angyal. Pp. xii+398. (New York: The Commonwealth Fund; London: Oxford University Press, 1941.) 13*s*. 6*d*. net.

The title of this work might lead one to think that it deals with a branch of psychology. In point of fact, however, it is an attempt to define a science of which psychology as we now know it would be a branch. The other branches would include physiology, sociology, and indeed all the studies with the human organism and its activities. Dr. Angyal suggests that the time has come for a radical reconstruction of this group of sciences, not one of which can deal adequately with its subject-matter so long as it remains in comparative isolation from the others.

In attempting to assess the value of an ambitious work of this description there are two points that must be considered. First of all, are there good grounds for believing that such a reconstruction is necessary, or even desirable? In the second place, does the writer succeed in showing that the reconstruction which he advocates is possible?

Dr. Angyal establishes the first point without much difficulty. There can be no doubt that the various branches of psychology present to-day an appearance of almost complete disorder. Indeed, it might be said that there is no psychology but only psychologies. So that it is most refreshing to meet with a resolute attempt to tackle the theoretical problems, even though the result may be yet another psychology. But the second point is the critical one. Dr. Angyal is not the first to attempt to unify this group of sciences, though his approach is a new one. Does he succeed in overcoming the difficulties which his predecessors failed to solve?

In our attempts to understand the world round about us we have hitherto had at our disposal two great instruments, language and mathematics. Language abstracts qualities and relations from the concrete mass of events, and by so doing enables us to discover structure and regularity. Mathematics specifies this structure in quantitative detail. Now Dr. Angyal would have us approach the concrete datum which we wish to understand, and, without abstracting or dividing, apprehend it in its original "wholeness". We should study the total human organism responding to a total environment. It will obviously be necessary for us to deal with partial aspects of this total situation at any given time; but when we do so we should consider, not parts merely, but parts of such and such a whole. In fact, Dr. Angyal is postulating not so much a new method as a new category, and therein lies the real objection to what is otherwise a very attractive programme. For we cannot simply by taking thought alter our existing categories. There is no need to adopt a Kantian point of view and claim that only certain categories are possible. It is enough to suggest that existing categories are embedded in our thought and language much more deeply than Dr. Angyal seems to realize. A quotation may serve to bring this out more clearly. "Biological tensions viewed from the subject as a point of reference are considered as drives. Viewing the same tensions from the object side one obtains something similar to what Kurt Lewin calls the 'field forces' or 'demand qualities' of environmental situations" (pp. 128–29). The rather clumsy periphrasis, "something similar to . . . 'field forces' or 'demand qualities' of environmental situations", shows the sort of difficulty likely to be met with. Dr. Angyal has been forced to express himself in terms of analogies with physical science or with the sort of descriptive analysis which he has already rejected. He is, moreover, unable to express the "wholeness" of the situation directly, but has instead to move rapidly backwards and forwards between the subjective and the objective sides.

Dr. Angyal is by no means unconscious of these difficulties, though he may not realize how fundamental they are. "Relational thinking", he admits, "is so firmly rooted a habit that the transition to system thinking is at least as difficult as the transition from a three-dimensional to a four-dimensional geometry" (p. 261). The point is, however, that given an instrument, the transition presents no difficulty. What is difficult, if not impossible, is to express four-dimensional geometry in terms of our immediate apprehension of three-dimensional space. This seems to be equivalent to the task which Dr. Angyal has set himself.

But it would be unjust to suggest that Dr. Angyal is merely attempting an impossible task. What he has done is to raise issues of a very fundamental kind, and to make a number of very stimulating suggestions. His basic principles are probably correct. We should treat the problem of human behaviour as he suggests. Unfortunately, it seems doubtful whether we can at present do so. But this does not mean that we can never overcome our present limitations, and Dr. Angyal's re-orientation may in time develop a vocabulary and set of operations suitable to its requirements.

In any event, Dr. Angyal's work is a very timely survey of the psychological wood, when so many psychologists refuse to look beyond the nearest tree. Some of them may produce useful logs, others may do no more than carve their initials on the bark; but unless they can fit their activities into a wider whole their work is likely to have only accidental value. J. Drever.

NEW METALS AND NEW METHODS*

By DR. C. H. DESCH, F.R.S.

THERE has been an enormous increase in the production of the most important metals, the output doubling itself in quite a short period: twelve years for copper, seventeen for pig iron, eighteen for tin, and so on. Along with this quantitative growth, the development of modern industry has brought with it remarkable qualitative changes, elements which until lately were curiosities of the laboratory rising into industrial importance. Aluminium, which seventy-five years ago had only been obtained in quantities of a few pounds, had a world production at the beginning of the War approaching a million tons, while its later development on both sides of the Atlantic has been on a very large scale. Aluminium is not one of the rare metals; it is, in fact, the most abundant of all metals in the earth's crust, but at present bauxite, a rich mineral of very local distribution, is alone used for its extraction. But elements of rare occurrence, such as tungsten, molybdenum and vanadium, now occupy, in consequence of the ever-increasing demands of the engineering industries for materials of higher strength or other special properties, a key position out of all proportion to their abundance. This is largely due to the discovery that the properties of a metal may be profoundly altered by very small additions of another element, metal or non-metal. Pure iron is even softer than copper, but less than 1 per cent of carbon converts it into steel which may be made so hard as to scratch glass. This fact had been discovered empirically many centuries ago, but now that the process is better understood there are many other instances of the same kind. Copper can be made hard enough to serve as springs and even as non-sparking mining tools by adding 2·5 per cent of beryllium, while the soft metal lead may be strengthened, so as to offer a greater resistance to frost when used for water-pipes, by alloying with so little as 0·05 per cent of tellurium.

These and similar observations have led to important developments in metallurgy depending on the use of comparatively rare metals which are mostly found only in local concentrations in various parts of the earth. In a statistical table, the production of some of the minerals from which these rare elements are obtained may not seem impressive, but the access to them may be an important factor in the capacity of a country to produce machinery and other constructions into which metals enter.

The usefulness of the less common metals is, of course, not confined to small additions. The possible combinations of metals with one another are virtually infinite, and in spite of the vast amount of research and practical experience in this field, there must be many valuable combinations as yet undiscovered. The first recognition, partly accidental, that steel could be made to resist corrosion by incorporating 14 per cent or so of chromium, led to the development of the important class of stainless steels, while the new magnet steels, containing aluminium and nickel, and in their later forms also cobalt and copper, have brought about a revolution in the construction of electrical instruments and loud-speakers, the very high magnetic concentration which is possible with them enabling very small permanent magnets to be used. For other purposes, such as the clutches used for holding work in milling and grinding machines, they replace electro-magnets. With these steels it is possible to realize the image of Mahomet's coffin—heavy bars floating in the air in consequence of their strong magnetic repulsion.

A few of the rare metals find applications depending on their own peculiar properties. Thus tungsten, with its very high melting point of 3650° C., has superseded all other materials for the filaments of electric lamps. The invention of the fountain-pen called for an exceedingly hard and incorrodible substance for the tips of the gold nibs, and this was found in a native alloy of osmium and iridium. Tantalum has proved specially suitable for the spinnerets used in making artificial silk, rhodium and indium for depositing in thin layers on other metals for protection against corrosion, and so on. The non-metal selenium is used in photo-electric cells. Further uses of this kind will present themselves as the properties of the less common elements are studied more completely.

The high melting point of some of the metals has led to research in two main directions. On one hand, it has been necessary to devise means of making metals compact and strong without melting them; and on the other, to develop new materials and new techniques for operations at temperatures higher than those in ordinary metallurgical furnaces. Tungsten cannot be melted in a container of any known refractory material. The powder obtained by reducing its oxide is therefore packed into the form of bars under pressure and heated electrically until the particles cohere, and is then hammered in a special way until its strength is sufficient to allow of it being forged or drawn into wire. The same process has been applied to other metals, and a new branch of technology, known as 'powder metallurgy', has grown up. Not only the metals of high melting point, but also copper, bronze, and even the low-melting alloys of tin, are prepared in the form of small particles and made to cohere by heat and pressure.

The method has several advantages. Small objects may be produced of accurate shape, requiring no machining, by pressing in dies, while the mass may be made completely solid or given any required degree of porosity. Such porous masses are particularly useful for bearing metals, the spongy metal holding the lubricant better than by any arrangement of grooves. The method of consolidating a powder is also used in the making of carbide tools. Certain very hard compounds, especially the carbides of tungsten and titanium, which for many purposes can replace diamonds, are brittle in the mass, but if crushed and mixed with a metallic powder, mainly cobalt, and then heated until perfect union with the binding material is brought about, yield a composite mass which is excellent for tools and dies.

The chief obstacle to chemical operations at very high temperatures, 1,600° C. or above, lies in the difficulty of finding materials for furnace construction and for containing vessels which are both strong and resistant to chemical attack at such temperatures. The ordinary fireclays become soft and are attacked by slags. A few oxides, especially alumina, magnesia, thoria, and beryllia, meet severe requirements in this field, but their refractory qualities are lessened by quite small proportions of impurity, and their preparation calls for special technique, which has been developed as a result of long research in the laboratory, but has as yet been little applied on a large scale. When such materials become available in quantity—and there is no difficulty in principle, although the procedure may be costly—we shall see important developments in chemistry and metallurgy at high temperatures. It is interesting to note that it is the oxides of some of the rare elements—thorium, beryllium and zirconium—which have the highest softening points among the refractory materials, so that their importance will grow with the extension of high-temperature processes.

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* Paper read at the Conference on Mineral Resources and the Atlantic Charter arranged by the Division for the Social and International Relations of Science of the British Association on July 25.

In the heating of metals or other conductors, it is not necessary that the heat should pass through the walls of the containing vessel, as it does when a metal is melted in a crucible furnace. Modern heating by induced currents of high frequency allows the heat to be generated where it is required; that is, within the mass to be heated. This involves a less severe tax on the refractory materials, and also makes it possible to enclose the charge in an outer closed vessel which remains cold, so that the operation can be carried out in a high vacuum or in an atmosphere of some inert gas. This is not merely a laboratory device, but is used on a large scale in a number of manufacturing operations, which will become more numerous in the future. Melting in a vacuum, out of contact with furnace gases, gives a means of preparing many substances in a state of great purity and soundness, unobtainable in other ways, and is already applied to certain alloys in amounts of several tons at a time.

Many chemical reactions are made possible or are accelerated by high pressures. The autoclave has long been a familiar piece of chemical plant, but some of the processes for the production of ammonia from the air or for the hydrogenation of coal to form oils and petrol called for higher pressures than those of the usual autoclave, and recent work, especially in the United States, has shown the remarkable results which may be obtained under pressures of many thousands of atmospheres. To construct vessels to be operated at such pressures, sometimes combined with high temperatures, naturally involves entirely new engineering methods. The materials used are mainly steels, although hard carbides may have to be used for certain parts; but for the highest pressures counterbalancing stresses have to be applied by shrinking one cylinder over another or in various ways producing an internal stress opposite to that which will arise in operation. Here is another new branch of engineering of great scientific interest, extending the range of usefulness of known materials.

The substitution of one metal for another for particular purposes is not always due to inherent advantages, but is often a consequence of a policy of self-sufficiency adopted by an industrial country. This motive has been very prominent in recent years. It is natural that Germany, producing much aluminium but very little copper, should adopt the lighter metal for overhead electric power cables, but a similar replacement in the windings of motors and dynamos was purely due to conditions of blockade and could not be defended on other grounds. During the period of armament and of hostilities such substitutions have been very numerous, but the subject is too big to be entered on here. A few instances of substitution under normal conditions may be mentioned. The saving of weight by using light alloys of aluminium or magnesium in place of steel has mainly been utilized in aircraft and rolling stock construction, but it has occasionally been applied in ordinary structural work. A bridge in Pittsburgh, having been condemned as insufficiently strong for the increased traffic, was lightened by replacing the wrought iron road girders and floor by aluminium alloy. The main girders were still in good condition, and the lightening of the dead load gave the bridge a new lease of life.

The substitution of one material for another is not, as a rule, a simple matter. Metals differ not only in strength but also in elastic properties, and this difference has to be allowed for. The new Quebec Bridge was designed to take advantage of the high tensile strength of nickel steel, the designers considering that the Forth Bridge, a very stable structure, was unnecessarily heavy. The disaster of 1907, when the unfinished bridge collapsed, was due to the crumpling of the lower members, although calculation had shown that the direct load-carrying capacity was ample. It has been proposed to use alloys of aluminium on a large scale in shipbuilding, their use in small vessels having proved successful, while the particular alloys used—those with magnesium—are highly resistant to corrosion by sea-water. In changing from steel to light alloy, however, it would not be enough to calculate the dimensions of each member to give a strength equal to that in a steel ship. The hull would float too high in the water, and problems of stiffness would arise from the very different elastic properties; to build a successful vessel the design would have to be new from the beginning.

So, when the hard carbide steels were introduced to take the place of tool steels for very heavy work or large output, allowing cuts to be made on a lathe at much higher speeds than before, advantage of the improved properties could not be taken until the machines themselves had been completely redesigned to allow of such high speeds without undue vibration; and in fact the introduction of carbide tools has meant a revolution in the machine tool industry, much plant intended for large outputs being rendered obsolete.

Three examples may be given of the substitution of an entirely new material for one of which the supplies have been found to be inadequate or too costly. Platinum, a metal of very local occurrence, has been largely replaced for chemical purposes, fused silica taking its place in the concentration of sulphuric acid, and iron oxide in various catalytic processes. On a larger scale, Chile nitrate, a product formed under quite exceptional climatic conditions and almost unique, is no longer indispensable as a fertilizer, the nitrogen compounds required for agriculture and explosives being obtained synthetically from the air. The third example is the introduction of plastics, resin-like substances which may be given the most varied properties. For many purposes they replace metals, and when reinforced by textile material or paper have a strength comparable with that of a metal. Transparent varieties replace glass and are far less brittle; other types take the place of porcelain and earthenware. The manufacture of plastics is one of the rapidly growing industries, and the uses of these new materials are continually being multiplied.

It must be realized that even such substitutions as these do not necessarily lessen our dependence on mineral resources, although the relative importance of different deposits may be altered. Nitrogen compounds are obtained by the use of electric power, which in some countries is derived from water, but in some of the most highly industrialized countries has to come from the combustion of coal. Many of the plastics are also derived from coal or petroleum, but being organic compounds, there is always the possibility of producing them from vegetable matter, as for example through the production of alcohol by fermentation and its conversion into more complex compounds. Such a procedure would be in line with the policy of depending on current revenue, derived from plants, rather than drawing unnecessarily on mineral capital, which once exhausted is not replaced.

Much might be said of means of economizing metals: the use of structures built up by welding, in place of heavy castings; the combination of concrete with steel in buildings and bridges; the saving of valuable metals by employing them as thin coatings on mild steel in chemical plant, and so on; but space does not permit. As new materials come into use and new techniques are developed, while at the same time the known reserves of some indispensable metals are being depleted, it becomes clear that the efficient use of the world's mineral resources demands systematic planning. First of all, a far more thorough world survey is needed, gathering together the information collected by prospectors in the interest of large industrial corporations as well as by the various national surveys. Such a survey would be the essential basis of any system of international control of mineral resources.

GROWING-POINTS IN THE STUDY OF GROWTH AND DEVELOPMENT

By DR. JOSEPH NEEDHAM, F.R.S.

EXPERIMENTAL morphology is a subject which has long suffered from the scattered nature of its publication mechanisms. The great series of the *Archiv. f. Entwicklungsmechanik* was at one time central, but is now, alas! no longer available, and though the American anatomical journals long offered a home for such studies, much of the work appeared in the proceedings of learned societies not always very accessible (for example, the Finnish contributions). Work on the borderlines of biochemistry and morphology, in particular, was widely scattered. Hence the need for some periodical publications of the regular conference type, to do for experimental morphology what the Cold Spring Harbor Symposia had begun to do so well for general physiology. The symposia now under review* are often referred to by the name of "Growth Supplements"; the correct description enshrining an auspicious pun. They will certainly stimulate the growth of our knowledge about growth and differentiation.

I had the good fortune to be present at the first two of these symposia. North Truro is a village lost among the sandy hills of Cape Cod, and there, in the spacious village schoolroom, under blue skies but with the shadow of war hanging over us, some hundred members met to discuss problems of experimental morphology. The proceedings were opened by an excellent account of the contributions of the explantation method by the veteran investigator, Warren N. Lewis. It is often forgotten that the discovery of the inductive action of the eye-cup on the presumptive lens tissue was discovered by him and Hans Spemann independently about the turn of the century, and that seven years later he narrowly missed finding that inductive action of the primary organizer itself which had to await the classical paper of Spemann and Hilde Mangold in 1924. Much of the rest of the North Truro symposium was, in fact, occupied by discussions of the present state of the organizer problem, in which valuable contributions were made by Paul Weiss. Arising out of Oscar Schotté's paper, considerable attention was given to the re-acquisition of competence by tissues undergoing regeneration, and the term 'recuperation' was proposed and adopted for this phenomenon. Curt Stern's paper was also very stimulating on the relation of genes and inductors. As regards growth proper, there was a good summary of the work on glutathione as a genetically controlled diffusible inductor working on body-size, by P. W. Gregory; and E. W. Sinott summarized his interesting investigations on the morphogenetic fields of the fruits of the Cucurbitaceæ.

The second symposium took place in the following summer at Salisbury Cove, Maine, and as there was not sufficient accommodation at the Marine Biological Station there for the meetings, we were kindly given the use of a charming wooden chapel in New England style, to which the members of the symposium were summoned by the ringing of the bell by the chairman. Here several brilliant summaries were given, particularly those by Douglas Whitaker on the mutual interactions of cells as exhibited in the early development of Fucus "eggs"; and by V. C. Twitty on the size-controlling factors in amphibian development, in which the complex questions of self-wise and neighbour-wise phenomena in growth of parts after transplantation and in physiological behaviour such as cardiac rhythm and pigment formation were lucidly described. H. Greene's account of the pathology of development, genetically produced abnormalities, etc., will also be found of much interest. For the biochemist, there was a brilliant account by the great physical chemist Freundlich (then at Wisconsin) of the colloid chemistry of development and growth, paying special attention to liquid crystalline phases in living cells, birefringence, importance of anisometric protein particles, etc. This article has also the melancholy interest of being the last which Herbert Freundlich wrote before his death. There was also an animated discussion of protein structure by O. L. Sponsler, well known as one of the earliest workers to apply the methods of X-ray crystallography to living structures (plant cell-walls).

The third symposium opened with an exceptionally important article by F. O. Schmitt on "protein patterns" in cells. This centred around the question of what it is exactly which happens to the cells of the presumptive neural tube in the embryo when, under the influence of the primary inductor, they

* First Symposium on Development and Growth, 1939; North Truro, Mass., ed. N. J. Berrill; contributions by W. H. Lewis, P. W. Gregory, C. Stern, C. H. Waddington, J. Needham, O. Glaser, O. E. Schotté, E. W. Sinott, J. H. Woodger; Supplement to *Growth*, vol. 3. Second Symposium on Development and Growth, 1940; Salisbury Cove, Maine; contributions by O. L. Sponsler, R. Schœnheimer, H. Freundlich, G. S. Avery, D. M. Whitaker, A. B. Dawson, V. C. Twitty, H. S. N. Greene, and F. S. C. Northrop. Supplement to *Growth*, vol. 4.

Third Symposium on Development and Growth, 1941; Hanover, New Hampshire; contributions by F. O. Schmitt, V. Tartar, K. B. Raper, A. F. Blakeslee, N. J. Berrill, A. H. Hersh, L. C. Dunn, and P. Weiss. Supplement to *Growth*, vol. 5.

All the Growth Symposia are obtainable as follows: by members of the Society for the Study of Development and Growth on application to Dr. J. W. Wilson, Biology Department, Brown University, Providence, R.I., U.S.A.; by non-members on application to the Editors of *Growth*, Dairy Building, Cornell University, Ithaca, N.Y., U.S.A. Prices: for members, vol. 1, 1 dollar, vols. 2 and 3, 2 dollars; for non-members, vol. 1, 2 dollars; vols. 2 and 3, 3 dollars.

change their shape by a profound elongation. While some workers are inclined to lay greatest emphasis on the existence of sub-microscopic anisometric protein micelles in the cytoplasm; while others suggest that the main factors are located in an ectoplasm similar to that which we know is responsible for the cell-shape changes in echinoderm egg cell-divisions; Schmitt and his colleagues direct attention rather to the cell-surface itself. The evidence for the 'zip-fastener' theory of neurulation must be read in the original, but it is sure that the time has come for an intensive attack on the cell surfaces by colloid chemists familiar with the properties of interfacial protein and lipo-protein monolayers. The recent fundamental work of J. Holtfreter on 'tissue affinities' in morphogenesis looks in the same direction.

Doubtless the most remarkable article in the third symposium is that of K. B. Raper on the developmental patterns in the simple slime-moulds. The facts there reported appear nothing short of amazing to the specialist in better-known fields of morphological study. Slime-moulds had indeed been coming into the limelight through the curious experiments of A. R. Moore on the ability of their protoplasm to pass through very fine filters, but its destruction if forced through much coarser filter pores. But now Raper describes for the benefit of biologists accustomed to less startling material how myriads of myxamœbæ of wholly different spore origin and initially equal potentialities come together in enormous numbers, integrate themselves into a co-operative functioning whole, and afterwards differentiate along specific lines within prescribed limits to produce a single fructification. The article is well illustrated with photographs and drawings showing how the myxamœbæ stream together towards a central mass or peg, which then lifts itself up and differentiates into a highly complex and specifically characteristic sorocarp. Congregations of myxamœbæ of different species move in to different centres. As if this behaviour were not enough, in some species the conjoined mass or "pseudoplasmodium" does a good deal of migration before it settles down and begins to differentiate. All these phenomena allow of much experimental analysis which has scarcely as yet been begun: the nature of the factors leading to aggregation, the mechanism of the movement of the pseudoplasmodia, and the factors governing differentiation of the sorocarp.

More familiar growth phenomena were not overlooked in the third symposium, however. A. F. Blakeslee gave a very interesting discussion of general growth patterns in plants, and heterogonic (allometric) growth problems in animals were well reviewed by A. H. Hersh. Finally, P. Weiss discussed the mechanics of nerve growth, dealing among other things with his 'deplantation' experiments, in which a piece of isolated nerve-cord and a detached limb are both implanted into the gelatinous connective tissue of the amphibian fin. Thus the gradual innervation of the limb and the spontaneous origination of rhythmical impulses from the nerve cord can be studied, as if in an elaborate form of tissue culture, subject only to the unavoidable endocrine environment of the host animal.

The above descriptions have not been able to do justice to more than a few of the admirable reviews in these symposia. By the time when this notice appears, the Fourth Symposium on Development and Growth, held at North Truro in August 1942, will be in course of publication. It was devoted to the general theme of the "Developmental Responses to Specific Chemical Agents" and included contributions by K. G. Stern on growth as a problem of chemical catalysis; E. L. Tatum on the relations between genes and growth hormones; E. J. Boell on the physiological and biochemical analysis of organizer action; P. R. White on developmental responses of isolated plant tissues; E. Allen on tissue growth and the sex hormones; F. C. McLean on ossification; O. A. Bessey on tissue responses to vitamin deficiencies; and A. J. Riker on pathological growth. It will certainly be as indispensable as the symposia which have preceded it.

If the present review serves to direct the attention of British experimental morphologists, in the widest sense of the term, to a series of conferences which are likely to remain for a long time the centre of these studies, and which, when the present troubles are over, may again unite biologists from both sides of the Atlantic, it will have achieved its purpose.

TEACHING OF COLOUR IN SCHOOLS

EDUCATIONAL reforms, large and small, are in the air. A great many people are taking advantage of the upheaval produced by the War to overhaul the existing educational machinery and to discover its weaknesses. Sometimes the material that is taught needs modernizing, sometimes it is the method of teaching that is wrong, sometimes there is a failure to arouse the latent interest and enthusiasm of a child in the fascinating natural phenomena that abound.

The subject of colour can occupy only a very small corner in the curriculum of school or university, but the phenomena of colour are so intimately woven into the pattern of human experience that what is taught is worthy of the best possible presentation. It is not an easy subject since there are too many avenues of approach—the physicist will want to start from the spectrum, the physiologist from the retina, the psychologist from the sensation, the artist from the point of view of beauty and harmony—but at least it is to be hoped that one teacher will not be in conflict with another.

It was no doubt partly from high academic motives such as these that the Physical Society Colour Group interested itself in the teaching of colour, but the Group also has its own problems which in part arise from the very diverse instruction on colour which members of the Group have received in earlier days. Some of these problems are concerned with terminology, which is anything but uniform; some are concerned with more fundamental matters, in which the principles accepted almost as axioms by one group of workers are neither understood nor accepted by other groups. Nothing would be more welcome to technical workers in colour than that their subject should be taught in a generally approved and consistent manner from the nursery upwards.

Co-ordination and combined operations are familiar phrases in these days and they might well be applied to the meeting arranged by the Colour Group on September 11 at the Imperial College of Science and Technology. Mr. E. G. Savage, education officer of the London County Council, gave a lecture with many demonstrations on "The Teaching of Colour in Schools" to an audience drawn from members of the Group, themselves representing a number of different colour interests, but augmented by members of the Science Masters' Association and of the National Society of Art Masters. It is a fortunate circumstance that a person in Mr. Savage's position is so intensely interested in colour, and the success of the meeting was in part due to the instructional value of the lecture and in part due to the many different suggestions advanced during the discussion for a more sympathetic alignment of the views of the scientific worker and the artist.

The greatest cause for dispute arises from the fact that the man of science, especially the physicist, deals primarily with the additive mixture of coloured lights, while the artist deals with the additive mixture of paints and pigments, which unfortunately acts as a subtractive mixture of lights. A yellow pigment is yellow because it absorbs blue light, and the more blue it absorbs, the yellower it becomes. A mixture of paints acquires its final colour through the absorption, or subtraction, of different parts of the spectrum in varying degrees by the component pigments. There is nothing very difficult to understand about this; yet the child is so accustomed from his earliest days to mixing, or adding, paints together, that he quite naturally considers that he is adding colours together; hence the results of colour mixing are conceived in terms of the results of paint mixing. This leads to a number of contradictions of which the most outstanding is the perennial argument as to whether yellow is or is not a primary colour. In passing, it may be mentioned that the argument is not made less complex by the just claim of the psychologist to regard yellow as a pure sensation. This, however, is another issue which must not be confused with the immediate problem concerning the mixture of lights and the mixture of pigments.

If we mean by 'primary colour' a colour that cannot be reproduced from the mixture of any other colours, then the physicist may with the greatest of ease show that he can produce yellow by adding red and green lights together. The artist, on the other hand, will show that he can produce green by mixing blue and yellow, but in no circumstances can he get yellow by mixing any other pair of paints. The artist may legitimately refer to yellow as a primary pigment; but he is in error in referring to it as a primary colour. There need be little difficulty in reconciling the two approaches, were it not for the fact that a child is used to handling paints from a very tender age, many years before he learns anything about the spectrum; when at last he does hear about the spectrum and its absorption, he will almost certainly have something to unlearn about colour and colour mixing. Perhaps the only solution to the problem is to introduce the spectrum to the student at as early an age as possible.

The spectrum was the centre piece in Mr. Savage's lecture. One of the first fallacies to be exploded is the not unreasonable assumption that white is the simple colour, while reds, greens and blues are more complex. Having shown that, physically, white light can be split up into its spectral components by means of a prism, it should next be explained why natural objects, such as grass, should be coloured. It is not sufficient, in fact it is incorrect, to state that the light reflected from the surface of the grass becomes coloured green. The light first has to penetrate into the grass, be absorbed inside the medium and the remnant reflected back from surfaces within the grass itself, before any colouring occurs. The light reflected from the front surface is uncoloured, as can be demonstrated by observing the images formed by reflexion in the front and back surfaces of a piece of coloured glass. This introduces the conception of absorption, which may be demonstrated without difficulty by projecting a spectrum on to a screen and inserting a number of colour filters into the beam in turn. Several interesting features then appear—such, for example, that a yellow filter does not merely transmit the yellow band in the spectrum, but in general transmits the whole of the red-yellow-green spectral region. Filters which show strong absorption are generally deep or saturated in colour, while those which show only slight absorption are desaturated or pale. In this way, by a series of experiments, it is possible to build up a general picture of the relation between the colours of objects as seen by the eye and the spectral composition of the light responsible for each colour.

When the physics of the problem has been grasped, it then becomes necessary to indicate that there are other factors at work; that what we see depends not only on the light sent out but also on the eye that receives the light. The effect of contrast, of adaptation, of after-images can be demonstrated without much trouble and indeed with very striking results, but to the young student these phenomena must undoubtedly appear as complicated factors of a somewhat baffling nature. This is surely the point where the art master and the science master should be particularly careful not to cause confusion by overstressing the subjective aspect of colour on one hand or the physics of the problem on the other.

There are many other aspects that can be considered: the effect of various types of illuminant, the possibility of reproducing any colour by the appropriate mixture of red, green and blue lights, the application of additive and subtractive mixture to colour photography and to colour printing, the formation of coloured shadows, and so on. If the subject is properly handled, it can be made an admirable medium for the teaching, not only of the facts of colour, but also of general scientific principles, and for the development of a healthy scientific curiosity. Why is the sky blue? Why do we get a muddy brown or grey when we mix all the paints in a paint box together? How do flowers get their colour? Perhaps even some history can be taught as well. It was mentioned, for example, that it was due to the influence of Chevreul that the French exhibit in the 1851 Exhibition outclassed the British, so far as colour and colour harmony were concerned.

It was very gratifying to find such a cordial spirit among the different interests represented at the meeting and to discover that each appeared willing and anxious to learn from the other. A mechanism for securing effective co-operation has still to be worked out; the question of a text-book is one problem, an agreed terminology is another. Mr. Savage has already contributed very greatly by the many lectures and demonstrations which he has given to groups of school teachers in various parts of Great Britain, and there is perhaps no better method of arriving at a consistent and acceptable doctrine of colour than through the missionary ardour he has revealed.

OBITUARIES

Prof. R. Willstätter, For.Mem.R.S.

THE death of Prof. R. Willstätter, which occurred at Muralto-Locarno, Switzerland, on August 3, a few days before his seventieth birthday, marks the passing of one of the great masters of organic chemistry.

Richard Willstätter was born at Karlsruhe on August 13, 1872, and received his early education at the Realgymnasium, Nürnberg. At the age of eighteen he entered the University of Munich, where he began his studies under Prof. Adolf von Baeyer. He remained at Munich until 1905, becoming while there *Privat-Docent* and then *extraordinarius* professor. In 1905 he was appointed professor at the Technische Hochschule, Zurich, where he remained for seven years. On the establishment of the Kaiser Wilhelm Gesellschaft laboratories at Dahlem in the suburbs of Berlin, he accepted the call there in 1912, holding the title of professor in the University of Berlin. On the death of von Baeyer he was appointed to succeed his old master at Munich. He remained in charge of the laboratories there until 1925 when, differing with the authorities on what he regarded as a matter of principle in university appointments, he resigned his chair. However, he was given facilities for work in his old department in a private laboratory, called after him the "Willstätter Laboratory", and there he continued, with assistance, his researches on enzymes. He seldom, however, visited this laboratory but directed the work mostly from his home in the Möhlstrasse. It was a source of special pleasure to him that his bust should be placed beside those of Liebig and von Baeyer in the corridor of the laboratories where he had been student and professor in turn. In 1939 he left his home in Munich, having narrowly escaped the concentration camp, and settled at L'Eremitaggio, Muralto-Locarno, where he lived the remainder of his life.

His wife died at an early age; his only son at the age of fifteen; he is survived by a daughter who is a mathematician and former pupil of Sommerfeld. He was awarded a Nobel Prize in 1920, and was a member of numerous learned academies and societies, including the Royal Society, the Royal Irish Academy and the Chemical Society. His portrait, in the series of "Scientific Worthies", appeared with the issue of NATURE of June 2, 1927, accompanied by an appreciative account of his work by the late Prof. H. E. Armstrong.

Very early in his career, Willstätter gave promise of great things to come. In the years 1893–94 there appeared six papers in conjunction with Einhorn on a variety of problems related to the alkaloids. His first independent publication dealt with the stability of ring systems, being a contribution to the 'strain theory' developed by von Baeyer. However, he developed at an early stage an interest in the constitution of the alkaloids and by a series of degradation experiments established the structural formulæ of cocaine and atropine, which he eventually synthesized in 1900–2. The latter work is detailed in 300 pages of the *Annalen*, a truly remarkable achievement on the part of the young scientific worker. He returned to the cocaine problem during the years of the War of 1914–18 and developed a technical synthesis on the lines of the classical work of Robinson.

The early years in Munich were also occupied with a variety of problems, among which were the production of *o*-benzoquinone, and various studies in catalysis. It was also towards the end of his first period at Munich that Willstätter began, with Stoll, his work on chlorophyll. On his translation to Zurich there began an intensive study of the natural colouring matters, principally chlorophyll and the carotenes. The nature of chlorophyll *A* and chlorophyll *B* was established, as was also the constitution of the chemically related blood-pigment hæmin. In the case of the carotenes, he established the highly unsaturated nature of these pigments, the structures of which were shown to be based on the isoprene unit. This period at Zurich was an extremely fruitful one in Willstätter's career, and the work on chlorophyll has been collected in a book written in conjunction with Stoll and published in 1913; this became known as "Das Chlorophyll-Buch". Gradually, Willstätter began to be interested in the biological significance of chlorophyll, and the results of this work, carried out largely in conjunction with Stoll during the Berlin period, appeared in 1918, over the names of the joint authors, as "Untersuchungen über die Assimilation der Kohlensaüre".

On going to Berlin in 1912, Willstätter entered on the second phase of his work on natural colouring matters. It was during his relatively short period there that he carried out his researches on the anthocyanins, the blue, violet and red pigments of fruits and flowers, in which he isolated the pigments in the pure condition as their salts, showed their glycosidic nature and their relationship to the yellow plant pigments, the flavonols. He established their constitutions and crowned the work by a synthesis of pelargonidin, the colour-base of the scarlet pelargonium. So complete was his survey of this field that, beyond hirsutin, found by Karrer in certain primulas, no significant addition has been made to the pigments isolated by Willstätter. In those days in Berlin it was pleasant to look out of the laboratory windows and to see the plots of poppies, dahlias, etc., which formed the raw material for his work, even though there was a sense of wasted effort when it was found that sufficient of the pigment of the dahlia could be isolated from a single bloom! It was during this period that he carried out his work on cellulose, while continuing research on chlorophyll and the alkaloids. Notwithstanding the success of his work, he did not regard his Berlin days as particularly happy, and no doubt the recent death of his wife helped to cast a shadow over this time.

With his return to Munich began the last phase of Willstätter's work. His earlier researches on chlorophyll marked his first encounter with enzymes, when he found that the phytol group of chlorophyll was removed in alcohol solution by chlorophyllase present in the plant. At Munich he began, with a brilliant band of collaborators, an intensive research on the isolation, reactions and constitution of enzymes. The results he collected and published in 1928 in two large volumes with the title "Untersuchungen über Enzyme". These volumes he dedicated to his life-long friend the late Prof. Fritz Haber.

When it is recollected that after the War of 1914–18 there was inevitably a period of delay before students were trained to the stage when they could become effective research workers, and when it is remembered that, in 1925, intensive research came to an end with his resignation from the University of Munich, the value and volume of work from Willstätter's laboratory during his short post-war period is astounding. This is not the place to recapitulate his contributions to enzyme chemistry; reference, however, may be made to the fact that he developed the technique, novel to this field, of selective adsorption in the preparation and separation of enzymes and expounded his theory of the active group associated with a colloidal carrier to explain their constitution. This work formed the subject of his Faraday Lecture given in London in 1927 and of the Willard Gibbs Medal address given at Chicago in 1933. After 1925 he continued to direct research, on a restricted scale, at the Willstätter Laboratory in the University of Munich, his principal collaborator being Dr. M. Rhodewald. What was probably his last publication appeared in 1940 in *Enzymologia*.

Willstätter liked it to be known to his friends abroad that, in the War of 1914–18, his sole contribution was of a humanitarian nature—he was the inventor of the three-layer protective filling of the German gas mask.

Though Willstätter is dead, he leaves behind him a band of former pupils who carry on his tradition in the academic and industrial spheres. There occur to one the names of Stoll, Kuhn, Waldschmidt-Leitz, Asahina, E. K. Bolton, Zechmeister, Forsén, Fourneau, Everest, Clarke, Page and a host of others all gathered together in that volume presented to him by grateful collaborators on his fiftieth birthday in Munich in 1922. The noble spirit that sacrificed itself for a principle, that declined invitations to work in other lands lest, in the acceptance, younger men might be deprived of their opportunities, is an abiding memory with all who had the good fortune to be reckoned among his friends.

THOMAS J. NOLAN.

Mr. F. W. Clifford

FELLOWS of the Chemical Society, and indeed all chemists who have occasion to use that Society's Library, must have learned with profound regret of the sudden death of the librarian, Mr. F. W. Clifford, at his home in Ealing on September 21. His illness in the early part of this year was a source of anxiety to his friends but he recovered and resumed his duties, and even a few days before his death seemed to be his normally cheerful and courageous self.

Clifford began his career in public libraries, first at Willesden Green and later at Hampstead, where he retained a connexion by evening work until 1903. He never lost his interest in this side of library work and was chairman of the Ealing Public Library Committee during 1923–27. In 1897 he accepted an invitation to become assistant librarian at University College, London, and, in the six years he spent there, gained valuable experience in the working of a large special library and himself contributed not a little to reforms in procedure. It was no doubt his experience and his efficiency in that position which led to his selection for the post which he was to hold with such success for the rest of his life.

When Clifford became librarian in 1903, the Chemical Society's Library contained about 15,000 volumes. The number is now about 45,000 and in peace-time is added to at the rate of nearly a thousand volumes a year. It was one of Clifford's greatest achievements that he contrived most ingenious methods of storing this huge accumulation of literature in the restricted space available in the Society's rooms at Burlington House.

Co-oerpation between British chemical societies began in 1919 and has now resulted, so far as the operations of the library are concerned, in the provision of a much wider range of technical chemical literature, a great extension of the clientele, and management by a Joint Library Committee on which all the associated and contributory societies are represented. Clifford rejoiced in these developments, and he and his staff worked loyally to promote them. As a result Great Britain now possesses what is probably the best chemical library in the world; it needs and has needed for years adequate housing.

Clifford was a member of many committees concerned with library matters. He provided written evidence for the report on Public Libraries in England and Wales presented to the Board of Education in 1927 and several of his suggestions were adopted in the report. He occasionally reviewed books on bibliographical subjects, and wrote a number of articles, of which one may be specially mentioned, "The Library of the Chemical Society: a Record of a Recent Attempt at Co-operation", published in the *Library Association Record* in 1919. He was a member of the Library Association and served on the council of the Association of Special Libraries and Information Bureaux during 1925–30.

Clifford never pretended to know the contents of chemical literature, but in knowledge of chemical publications of all kinds he probably had no equal. The story is told that on one occasion a candidate for a Ph.D. degree, persistently questioned by his examiner as to what literature he would consult in starting research on a new subject, quoted the usual German handbooks, dictionaries, etc., only to be met with the further inquiry, "And after that?", to which he provided the final answer, "I would then go to the Chemical Society's Library and consult Mr. Clifford." Clifford was always ready to give help of this kind and grudged neither time nor patience in his desire to be of service to inquirers. This kindness was based on a broad love of humanity as exemplified in his enthusiastic work for the St. John Ambulance Brigade, for which he did great service. For this he was made a 'serving brother' of the Order of St. John of Jerusalem in 1926, an officer of the Order in 1936 and in March of this year was given the rank of commander, a fitting tribute to a life spent unobtrusively in the service of his fellows.

T. A. HENRY.

Mr. B. M. Neville

MR. BERNARD M. NEVILLE, who died in April of this year at the age of fifty-five, was a schoolmaster whose outstanding abilities would have made a mark in any circumstances; but they were the more remarkable in view of the distressing disability which from childhood had stunted his growth but which had signally failed to check his enjoyment of life; he would have been the first to acknowledge how much it was due to the devotion of his mother that he refused to admit his physical limitations.

He was educated at William Ellis School, where he was physics master for more than thirty years, until his untimely death, and at Birkbeck College, of which he was a governor for twenty-four years. He was a Neil Arnott scholar of the University of London, and took his honours degree in physics in 1909. Later he became an associate of the Institute of Physics and a fellow of the Physical Society, and he was a prominent member of the Science Masters' Association, being a member of the Committee and for some years treasurer. He was a skilful experimenter, and his class demonstrations and lessons gave to many boys an enduring interest in science, and an appreciation of accuracy and general scientific technique which stood them in good stead whether they proceeded to more advanced scientific studies or turned to other pursuits.

His loss is mourned by many, to whom he was a patient teacher who spared no effort to help the willing, to whom he was a never-failing inspiration in the courage with which he faced an adversity that (in the words of another) "would have crushed the spirit and soured the nature of all but a very few", and above all, to whom he was a faithful and affectionate friend.

D. G. A. DYSON.

WE regret to announce the following deaths:

Prof. G. G. Henderson, F.R.S., emeritus professor of chemistry in the University of Glasgow, on September 28, aged eighty.

Prof. R. C. Robertson, professor of pathology and bacteriology in the University of Hong-Kong, on August 4, aged fifty-two.

Mr. E. T. Sandars, O.B.E., author of popular handbooks of natural history, on September 19, aged sixty-five.

Mr. A. R. Warnes, author of works on coal tar distillation and known for his special study of the restoration of stonework and ancient buildings, on August 25, aged sixty-four.

NEWS and VIEWS

Cultural and Scientific Mission in China

IN amplification of the note on this subject which appeared in NATURE of September 26, p. 369, Prof. E. R. Dodds, F.B.A., of the regius chair of Greek in the University of Oxford, will also be proceeding to China shortly on a mission of cultural co-operation, like Dr. J. Needham, F.R.S., on behalf of the British Council. In Chungking he will be attached to the Sino-British Cultural Association, and he will present letters of greeting to Academia Sinica (the National Academy of China) from the University of Oxford and the British Academy. Prof. Dodds will visit as many as possible of the Chinese universities and cultural institutions, and his stay will certainly do a very great deal to strengthen Sino-British cultural relations. It may be added that Dr. E. R. Hughes, reader in Chinese in the University of Oxford, has already been for nearly a year in China, at Kunming and other university towns, doing similar valuable work. The visit of Prof. Dodds and Dr. Needham was recently noted by the well-known Chinese newspaper, *Ta Kung Pao*, which published a leading article welcoming them in the warmest terms, and expressing the hope that the interchange of scientific workers and scholars between China and Britain may take place in the future on a much wider scale than hitherto.

Research and Research Workers in War-time

THE September number of the *Wireless Engineer* contains an editorial on "Research and Research Workers" with special reference to the demands of the present war effort. Under normal peace-time conditions, fundamental and applied research are carried on in one or more of three places: the colleges and universities; the various Government laboratories and those of research associations; and the research and development laboratories of industrial manufacturing companies. The demands of war render it necessary for the workers in these three groups of laboratories to intermingle to a considerable extent and to co-operate as a team in order that useful ideas may be built upon sound foundations and developed as rapidly as possible into practical technique and equipment which can be directly utilized by the Services. There is much controversy over the status of the research worker in the various institutions and laboratories, and the inadequacy of the supply of suitably trained workers with the right ability has given some of them an exaggerated view of their indispensability. On the other side, some industrialists not infrequently express their disappointment regarding the results of research as affecting their particular line of business. This is sometimes due to the lack of appreciation by the employer of the needs of the research worker, who cannot always produce results to order; there is on occasion a fault to be sought out and eliminated on the other side.

While the immediate needs of war tend to restrict long-term fundamental researches, it must be remembered that it is this type of research which in the long run yields the new developments in the commercial fields. But the greater intensity of, and the larger number of workers engaged in, applied research during a war period will undoubtedly pave the way for revolutionary developments afterwards. Thus the temporary sacrifice that the scientific investigator has to make at the present time, in abandoning the alluring search for truth for its own sake, is at least partly compensated by the knowledge that the diversion will in all probability yield things of great value when peace returns.

Universities of India

A VALUABLE survey of the work of the universities of India was given by Dewan Bahadur S. E. Runganadhan in a lecture before the India and Burma Section of the Royal Society of Arts on April 10 (*J. Roy. Soc. Arts*, Sept. 18). The paper gives a concise survey of the facilities for scientific research which have been developed in the last twenty-five years; a list of theses which have been accepted by Indian universities for the award of research degrees in recent years, which is appended, gives some idea of the standard of research work carried out in these universities. The subjects selected for special study under chemistry have a bearing on important economic plants, like jute, and Indian medical plants, and research on zoology includes valuable studies on parasites. The papers on botany indicate that there is considerable scope for the extension of research to more practical aspects of the plant life of India.

The importance of further co-ordination of university work in India is stressed, and the suggestion is made that some body corresponding with the University Grants Committee of Great

Britain, with a full-time chairman and secretary, should be constituted by the Central Government in India to advise on the distribution of funds available. Such a body would be in a position to give authoritative advice and guidance to the universities, without interfering with their economy, not only in regard to general expansion, but also as to the special lines of research they can most usefully undertake. There is a similar need for collaboration between the universities and various research institutions in the country, and particulars of some of the institutes which function as common federal institutions for advanced technical training and research are included in the paper. Some reference to the corporate life in the universities and the importance of continued contact between British and Indian universities both in regard to teaching, research and students is also included.

Tercentenary of the Calculating Machine

THE first calculating machine was invented in 1642 by Blaise Pascal. Had it not been for the War, the tercentenary of this event, which has had such a profound influence on applied mathematics and physics, would have been appropriately celebrated in Paris. In order that the date may not pass unnoticed, a small committee representing the Fighting French and British men of science, inventors and users has arranged a memorial luncheon to be held on October 19, at the Connaught Rooms, Great Queen Street, London, W.C.2, at 12.30 for 12.45 p.m. Prof. S. Chapman, president of the Royal Astronomical Society, will propose the toast of "Pascal—the inventor of the first calculating machine". The reply will be by Prof. R. Cassin, Commissaire National à la Justice et l'Instruction Publique. Other members of the Fighting French and French men of science in Great Britain will be present. Invitations are being sent to those who have been conspicuously associated with the development of calculating mechanisms, and to distinguished users of calculating machines, both scientific and industrial; tickets can be obtained from Miss M. E. Purves, 23 Bedford Square, London, W.C.1.

The luncheon will be followed by a small exhibition from 3 until 6 p.m. of calculating machines, with particular emphasis on models to show the actual mechanical working. A replica of the first machine made by Pascal will be exhibited and also a replica of the first calculating machine made in England by Samuel Morland in 1666. Demonstrators, in no way connected with the selling of machines, will explain the machines and models to visitors. Two 15-minute lectures have also been arranged, one at 3.30 by Dr. L. J. Comrie on "Mathematical Gymnastics with Calculating Machines", and the other at 4.30 by Mr. R. S. Nilsson on "A Description of Calculating Machine Mechanisms".

The British Astronomical Association

ON the invitation of the president and council of the Royal Astronomical Society, the British Astronomical Association is to be accommodated in future in the rooms of the former at Burlington House, London. Negotiations have been proceeding for some months and the final arrangements were completed in time for the British Astronomical Association to hold its first meeting in the new premises on September 30. A large part of the proceedings was devoted to a survey of the history of the Association since it was founded in 1890, special mention being made of its founder, Mr. Edward Walter Maunder. A number of members spoke about the progress of the Association during the fifty-two years of its existence and about the influence of many of its past members in shaping its policy and assisting with its remarkable development. It is worth noticing that the present international crisis has not affected its membership adversely—an indication of the interest which the amateur possesses in various astronomical branches. The new premises provide more adequate accommodation for the library and in other ways supply great facilities for the members, to whom the change has given considerable satisfaction.

Conference of Scientific Workers at Manchester

ON September 27, the North-West Area Committee of the Association of Scientific Workers arranged an all-day conference in Manchester on "Science and Total War". Opening the morning session, Prof. H. Levy asked the conference to consider the scientific effort of the country against the background of the slavery to which, literally, Hitler is subjecting the scientific workers and peoples of Europe. Total war demands total production at home, total production in the scientific sense. One of the biggest factors in ensuring total production, he said, are the production committees at which management and workers may overcome their traditional antagonism. Research must be centrally and co-operatively organized. The armed forces should select their officers scientifically and should ensure that there are sufficient technicians in the field to deal with problems as they arise.

Mrs. Barbara Ruheman described the contribution of science to the war-effort of the U.S.S.R., stressing the central position held by the Soviet Academy of Sciences in all Russian planning schemes. There is an intimate collaboration between the designer of a new fighter, for example, and the pilots who actually fly it. At the afternoon session difficulties arising in the working of production committees were discussed by speakers representing shop-stewards, engineers and chemists. These contacts were valuable in breaking down misunderstandings between workers and technicians. Resolutions were passed supporting the establishment of a whole-time central scientific and technical planning board, urging the strengthening of the Ministry of Supply's Synthetic Rubber Committee by the inclusion of technical experts, and the pooling of information, especially between firms engaged on medicinal research and production.

Biology and Control of the Bed-bug

THE Medical Research Council has recently issued in its Special Report series, No. 245, a "Report of the Committee on Bed-bug Infestation 1935–1940" (H.M. Stationery Office, 1942. 1*s.* net). It is in the form of a 64-page brochure which comprises six sections on the subject, concerned with the varied aspects of the problem, each being contributed by different specialists. In the section on new data bearing upon the ecology of the bed-bug, it is gathered that, provided a source of blood is available, temperature is the most important environmental factor. In unheated rooms the winter mortality of the bug population may be as high as 80 per cent, whereas in warmed rooms the population tends to increase enormously from year to year. The threshold of activity of the insect may be so low as 7–10° C., while a temperature of 13–14° C. is most favourable to a long life of the insect in the absence of food: both above and below this temperature life is definitely shorter at comparable humidities. For long life a high humidity is essential. At 45° C. (113° F.) the eggs succumb in one hour, and the adults in the same time at a temperature one degree lower.

As regards insecticidal methods of eradication, sulphur dioxide has proved to be a poor ovicide and not very toxic to the immature bed-bugs. An account is given of the circumstances leading to the abandonment of orthodichlorbenzene as a fumigant against the insect. Heavy naphtha is shown to be a useful contact insecticide, while its vapour action is particularly effective. The practical uses of hydrogen cyanide and heavy naphtha as fumigants have been investigated and conditions governing their application specified. Details are also given of the experimental methods used to test the effects of the insecticides employed on man. Of those investigated, orthodichlorbenzene is shown to be dangerous and heavy naphtha relatively safe. The concluding section is concerned with building design in relation to bed-bug infestation. It is stressed that new buildings should be so constructed as to provide the minimum harbourage for the insect and allow of its cheap and easy eradication in the event of infestation occurring.

Determining Colour in Telephone Cable

A METHOD is described by C. T. Wyman (*Bell Lab. Rec.*, **20**, No. 11, July 1942) of correctly determining the colour of conductor insulation papers, which, moreover, permits the use of a range of colours otherwise unobtainable. The system uses a scheme of colour notation developed in recent years by A. H. Munsell, in which each colour is specified by stating certain values for three parameters called 'hue', 'value' and 'chroma'.

'Hue' corresponds most nearly to what is normally called colour, five basic hues being used—red, yellow, green, blue and purple. Five intermediate colours—yellow-red, green-yellow, blue-green, purple-blue and red-purple—are also designated, and each of these ten hues is divided decimally to give ten sub-hues. Any hue is specified by a letter and a number from one to ten; thus 2*R* represents a red approaching the red-purple. 'Value' represents that characteristic most nearly described as 'lightness' or 'darkness', and is specified by a number from one to ten following the letter or letters designating 'hue'. 'Chroma' represents the degree of colour of any one hue, and is also represented by a number immediately following the 'value' number, but separated from it by an oblique line. A zero chroma would be a complete absence of colour, and would thus be a light or dark grey, depending on the value. A simple system of matching is thus available. It is not necessary to make samples of all the colours, however, because any colour may be obtained by mixing certain other colours.

In the method described several differently coloured disks are interleaved and the assembly is caused to rotate. The individual colours disappear and are replaced by a single colour corresponding to the particular combination. The Munsell Color Co. makes up a series of disks using light-fast dyes. These disks have a central hole to fit on the spindle of a motor, and a radial slit from rim to centre. A group of colour disks is selected which, when properly proportioned, will give the required colour, the disks being interleaved through the medium of the radial slots. The method has recently been adopted to secure colour standards for cable insulation, using a card carrying a peripheral scale mounted on the spindle behind the disks to provide a ready means of determining the percentage of each colour that is exposed.

Thickness of Aluminium Oxide Coatings

ALUMINIUM surfaces in telephone apparatus are sometimes protected by an electrochemically deposited oxide coating. It is important to control the thickness of these deposits and several methods have been tried. A majority of them, such as scratching the surface, stripping the deposit to weigh it, and measuring the thickness of a cross-sectional cut under the microscope involve destruction of the sample. A quick and reliable method, which is not subject to this limitation, is described in the *Bell Laboratory Record* of July 1942. It measures the voltage required to break down the oxide coating and punctures the specimen with so small a hole that it is not appreciably marred. A chromium-plated sphere about $\frac{1}{8}$ in. diameter is pressed against a thin plate of oxide-coated aluminium until the force, as indicated by a calibrated spring, is 1–2 kgm. Increasing voltages up to 1,500 are then applied, and that at which breakdown occurs is noted, the current being limited by resistors. This method has been used in the Bell Laboratories to study the relation between film thickness and the time to make the deposits electrochemically. The thickness obtained by an average of several readings is generally within ten per cent of the value found by direct measurement with a microscope.

Alcoholism and Crime

IN a recent paper (*Quart. J. Studies on Alcohol*, **2**, 686; 1942) Dr. Ralph S. Banay, chief psychiatrist to Sing Sing Prison, New York, records his experience of this subject based on detailed examinations, laboratory studies, social investigations and years of follow-up in confinement or supervision on parole. Statistical data showed that the principal difference between the alcoholic criminal and the non-alcoholic criminal was the high incidence of assault among the former, while in the latter crimes against property took precedence. This seemed to suggest that the primarily intemperate individual was drawn into crime not only for the need of money but also by the increased irritability, irascibility and pugnacity of the protracted alcoholic state. In conclusion, Dr. Banay deplores the fact that though a large number of all types of alcoholic offenders are passing through many corrective institutions throughout the United States, little is done for the study, understanding, prevention and treatment of them.

Dr. Wilhelm Camerer

DR. JOHANNES FRIEDRICH WILHELM CAMERER, an eminent physiologist and pædiatrician, was born at Stuttgart, the son of a well-known medical man, on October 17, 1842. After studying medicine at Tübingen and Vienna, he qualified in 1866 and for some years was engaged in private practice and public health work. Ill-health, however, compelled him to abandon these activities, and he devoted himself to scientific research at Urach in Würtemberg. His principal work was connected with metabolism in the child, on which he published a classic entitled "Der Stoffwechsel des Kindes von der Geburt bis zur Beendigung des Wachstums" in 1894, for which he was awarded the Niepel Prize. He also studied the metabolism in obesity, gout, diabetes mellitus and chronic renal and cardiac disease. In 1908 he contributed two important articles to Pfaundler and Schlossmann's "Diseases of Children" on "Metabolism and Nutrition in the First Year of Life" and "Children's Growth in Weight and Height". For some years he collaborated with Fechner, the experimental psychologist, in experiments on taste and touch. His interest in public health is shown by his papers on infant mortality and diphtheria. In recognition of his labours he was elected to an honorary doctorate of the Faculty of Natural Science of the University of Tübingen. He died on March 25, 1910.

ASLIB Conference, 1942

The Association of Special Libraries and Information Bureaux has arranged a conference to be held during November 7–8 in the rooms of the Royal Society. The preliminary programme includes an address by Sir Richard Gregory on "International Systems and Standards", a symposium on the use of microfilm, and papers on library training and on war-time books and periodicals. Most of the papers will be available in advance. It is also announced that discussion groups are to be formed in provincial centres, where those unable to attend the London conference can meet to discuss the papers presented.

The Nutrition Society

A whole-day conference of the Nutrition Society will be held at the London School of Hygiene, Keppel Street, London, W.C.1, on October 17, to discuss "Trace Elements in Relation to Health". Papers will be read by Dr. H. H. Green ("Significance of Trace Elements in Relation to Diseases of Plants and Animals"), Dr. R. L. Mitchell ("Distribution of Trace Elements in Soils and Grasses"), Prof. D. Keilin and Dr. T. Mann ("Copper, Zinc and other Trace Elements in relation to Physiological Function and Enzyme Systems"), Prof. T. Dalling ("Enzootic Ataxia or 'Swayback' of Lambs in England in relation to Copper Feeding of Ewes during Pregnancy"—film with running commentary), Sir Charles Martin ("Cobalt and other Trace Elements in relation to Disease in Australasia"), Dr. W. Lyle Stewart ("Sheep 'Pining' in Britain"), Dr. M. M. Murray ("Fluorine in Human Nutrition; *a*, Biochemical Aspects"), Dr. D. C. Wilson ("Fluorine in Human Nutrition; *b*, Clinical Appreciation of Fluorine Distribution"), Mr. F. H. Kemp ("Fluorine in Human Nutrition; *c*, Radiological Investigations"), Mr. F. Blakemore ("Industrial Fluorosis of Animals in England"), Mr. W. S. Ferguson ("'Teart' of Somerset; a Molybdenosis of Farm Animals"), Dr. R. A. McCance and Miss E. M. Widdowson ("Absorption and Excretion of Trace Elements"). The chair will be taken at the morning session by Dr. J. Russell Greig, and at the afternoon session by Prof. C. R. Harington. Further details of the Nutrition Society can be obtained from the hon. secretary, Dr. Leslie Harris, Nutritional Laboratory, Cambridge.

Announcements

Sir Henry Dale, president of the Royal Society, has accepted the directorship of the Laboratories of the Royal Institution, with the Fullerian professorship, in succession to the late Sir William Bragg. Sir Henry has expressed the wish that his appointment should be limited to a period of three years, so that the managers of the Royal Institution may then be free to consider their future policy.

Dr. Dudley Stamp has been appointed adviser on rural land utilization to the Minister of Agriculture. Dr. Stamp is director of the Land Utilization Survey of Great Britain and was vice-chairman of the Scott Committee on the utilization of land in rural areas.

Dr. John F. J. Dippy, of the staff of Cardiff Technical College, has been appointed head of the Chemistry Department of Wigan and District Mining and Technical College, in succession to Dr. T. Heap, who has been appointed principal of Batley Technical College.

At the annual general meeting of the Physical Society held on October 2 the following officers were elected for the year 1942–43: *President*, Sir Charles Darwin; *New Vice-Presidents*, Prof. C. D. Ellis and Dr. H. T. Flint; *Honorary Treasurer*, Dr. C. C. Paterson; *Honorary Secretaries*, Mr. J. H. Awbery (Papers) and Dr. W. Jevons (Business); *Honorary Foreign Secretary*, Sir Owen Richardson; *Honorary Librarian*, Prof. L. C. Martin; *New Members of Council*, Mr. E. R. Davies, Dr. W. B. Mann, Mr. A. J. Philpot, Prof. H. C. Webster, Dr. W. D. Wright.

Lord Hirst of Witton, honorary member of the Institution of Electrical Engineers, has given £20,000 for the use of the Benevolent Fund of the Institution. It will be known as the Lord Hirst Fund to give assistance to applicants for help (or to their dependants) who have rendered important services to electrical science, or electrical industry or electrical engineering.

The Institute of Physics has arranged a discussion on the "Education and Training of Physicists", to be held at the Royal Institution on October 12. The discussion, which is to be in two sessions beginning at 10.30 a.m. and 2 p.m., will be based on the memorandum on the subject prepared by the Planning Committee of the Institute.

Already the Association of Scientific Workers has organized two conferences in London and two area conferences on the theme of "Science for Victory". A third area conference is to be held for South Wales at the Royal Hotel, Cardiff, on October 18. It will be in two sessions, beginning at 10 a.m. and 2.15 p.m. Five speakers lead each session, at the end of which there will be an hour for discussion. Abstracts may be obtained from the Association prior to the meeting.

The name of Dr. Wadie Tadros should have been included as a joint author with Dr. J. M. Robson and Prof. A. Schönberg of the letter entitled "A New Synthetic Œstrogen with Prolonged Action when Given Orally", published in Nature of July 5, p. 22. The omission arose through difficulties of rapid communication with Egypt.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Polyploid Inheritance in *Lythrum salicaria*

NEARLY thirty years ago attention was directed by N. Barlow[1] to the genetic problem presented by the inheritance of style length in the trimorphic heterostylic plant *Lythrum salicaria*. Barlow was able to show that the long-styled plants were true-breeding recessives, and that Short differed from Long and Mid plants in a single epistatic dominant factor. The hypostatic factor responsible for Mid style-length was shown to present anomalies, first in that homozygous Mids, giving, when crossed with Long, all-Mid progenies, were not found, and secondly, in the occurrence of progenies with four or more times as many Mids as Longs.

The theory of a simple hypostatic factor for Mid has been since revived by von Ubisch[2], without, however, offering any explanation of the anomalies to which attention had been directed by Barlow. In 1927, East[3], on the basis of extensive experiments confirming Barlow's facts, proposed that the Mid style was produced by either of two duplicate factors, which were both lethal when homozygous, one rather closely linked; so that the abnormal ratios might be produced by double heterozygotes carrying the two dominant genes in repulsion.

Two years ago[4], we published the results from reciprocal progenies obtained by interbreeding a Short plant carrying Mid, with a Mid daughter, obtained by crossing with Long. These two parents thus certainly carried the same Mid gene. Apart from Shorts, these critical progenies gave a good ratio of 3 Mids : 1 Long, and significantly contradicted the ratio 2 : 1 which would be expected from a lethal gene. We inferred that our Mid gene was certainly not lethal, and that some plants of these progenies, namely, one third of the Mids and one quarter of the Shorts, must have received the same gene from both parents. We suggested that the Mid : Long segregations observed by Barlow and East might be explained by the inheritance being polysomic[5], a possibility which is in full accord with the fact that *L. salicaria* has a chromosome number of 30, the basic number of the genus being 5.

Twelve of the Mid plants and sixteen of the Shorts were therefore crossed with Long, by open pollination, in 1941, and progenies from their seed have been grown this year. Plants which had received the Mid gene from neither parent would be expected to throw no Mid offspring; the expectation is that 4 of the Short plants should be of this type. Plants receiving the Mid gene from one parent only should give equal numbers of Mid and Long; 8 of the Shorts and 8 of the Mids were expected to fall into this class. Finally, plants receiving the Mid gene from both parents should throw no Longs if inheritance were simply disomic; they would be the homozygotes missing from Barlow's experiments. With simple tetrasomic inheritance, however, they should give 1 Long to 5 Mids, and with simple hexasomic inheritance (a possibility proposed to us by Darlington on cytological grounds) the ratio is 1 to 4. The distinction between the two kinds of polysomic inheritance is thus difficult to draw, but that inheritance is polysomic our experiments leave no doubt.

Table I gives the classification of the 16 progenies from Short-styled plants. There are 1,138 Short observed to 1,199 not Short, a small deficiency of Shorts, which is reassuring since any illegitimate pollination in this group would tend to give more than 50 per cent Short. The single Mid in the first line is thus probably due to stray pollen. A peculiarity noticeable this year, though certainly absent in 1940 and 1941, is that the Mid plants have flowered on the average before the Longs. Consequently, the excess of Mids among the families from simplex parents may be due to a number of Longs having failed to flower in their first year.

TABLE 1. PROGENIES FROM 16 SHORT-STYLED PLANTS

	L.	M.	S.	Total
Nulliplex, 1 family	70	1	77	148
Simplex, 11 families	396	458	795	1649
Duplex, 4 families	48	226	266	540

TABLE 2. PROGENIES FROM 12 MID-STYLED PLANTS

	L.	M.	S.	Total	Failed to flower
Simplex, 8 families	194	236	1	431	47
Duplex, 3 families	15	74	–	89	24
Triplex ? 1 family	—	41	–	41	8

Table 2 gives the classification of the twelve progenies from Mids. The single Short plant is certainly to be ascribed to stray pollen, which, as in previous years, has been of trifling frequency. The ratio Mid : Long is but little higher than for the Short progenies, which had grown well, whereas the Mid progenies suffered much seedling mortality. There is thus no reason to suspect illegitimate pollination as its cause.

The ratio Mid : Long in the duplex families is 4·708$\dot{3}$ in the families from Shorts, 4·9$\dot{3}$ in those from Mids. If adjusted for the disturbed ratio shown in the simplex families, these become 4·071 and 4·055. Taking both lots together, the adjusted value is 4·048. For what they are worth, therefore, these families favour the hexaploid ratio of 4 : 1 rather than the 5 : 1 appropriate to tetraploids.

The exceptional family may be plausibly interpreted as due to a triplex parent. Such a plant can arise from the fusion of a gamete carrying one Mid gene with another carrying two. Exceptional gametes of the latter kind are known to be produced occasionally as a result of the process termed double reduction, the exact frequency depending on the rate of crossing-over between the gene and the centromere, and the formation of multivalents, at meiosis. If inheritance is hexasomic, a triplex Mid is expected to give, on crossing to Long, at least one Long offspring in twenty; but with tetrasomic inheritance, Long progeny will be produced only rarely, by the same exceptional double reduction which originally gave rise to the triplex Mid. The present data are insufficient to decide between these segregations, being, in fact, in accord with both.

During the next three or four years we hope not only to investigate this exceptional plant, but also to continue our programme by building up plants known to be triplex, and testing their genetic behaviour. A fuller account of the researches to this year will be published in the *Annals of Eugenics*.

Galton Laboratory,
at Rothamsted.
R. A. FISHER.

K. MATHER.
John Innes Horticultural Institution, S.W.19.

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[1] Barlow, N., *J. Genet.*, **3**, 53 (1913).

[2] Ubisch, G. von, *Biol. Z.*, **41**, 88 (1921).

[3] East, E. M., *Genetics*, **12**, 393 (1927).

[4] Fisher and Mather, NATURE, **146**, 521 (1940).

[5] Fisher, R. A., *Annals of Eugenics*, **11**, part 1, 31 (1941).

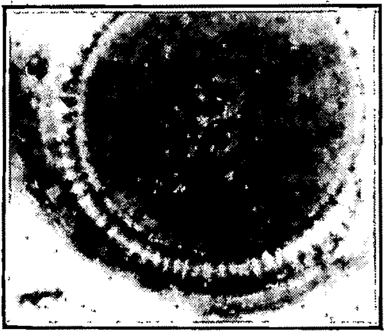
Genetic Classification of Brassica Crops

LAST May we were asked by Messrs. Carter whether there was any danger of intercrossing between kales and swedes. No precise information was available and classification by morphology offered little help for, as Bailey[1] remarks, the "*Brassica* group is indeed perplexing, excepting *Rubus* the most bewildering I have attempted". Indeed, in Brassica, we find it less confusing to use the English rather than the Latin names. To add to the confusion the kale concerned, Hungry Gap, was itself reputed to be a cross between widely different types. Therefore, we examined as many types of kale as we could obtain to find whether the chromosome number would throw any light on the situation.

Our results show that the kales are of two types, as follows:

	$2n = 38$	
Late Rape Kale	Hungry Gap Kale	Asparagus Kale
	$2n = 18$	
Dwarf Scotch Kale	Cottager's Kale	Perpetual Kale
Hearting Kale	Thousand-headed Kale	Marrow-stemmed Kale
Russian Kale	Curly Kale	Ragged Jack Kale

The swede has already been shown to be an allotetraploid, $2n = 38$, the result presumably of a cross between a cabbage type $2n = 18$, and the turnip $2n = 20$ [2,3]. We now see that three of the kales have the same chromosome number as the swede and they have no doubt originated by a process parallel to that of the swede, for example, by polyploidy following a cross between the 18 and 20 chromosome forms:



Pollen grain mitosis in Hungry Gap Kale showing haploid complement of 19 chromosomes

It may be concluded that the kales with 38 chromosomes will readily cross with each other and with swedes, while those with 18 chromosomes are only expected to cross readily among themselves and with cabbages, Brussels sprouts and other European forms of the 18 chromosome group.

Hitherto, the chromosome number in rape kale has been reported as $2n = 36$ [4]. As shown in the above table it is $2n = 38$. The swede rape also has the same number. The Hungry Gap kale is reputed to be a cross between late rape kale and curly kale. Since curly kale belongs to the diploid group it cannot well have been one of the parents. Hungry Gap must rather be derived from crossing within the tetraploid group.

P. T. THOMAS.
M. B. CRANE.

John Innes Horticultural Institution,
Merton, S.W.19. Sept. 15.

[1] Bailey, L. H., *Gentes Herbarum*, 2, 212 (1940).

[2] Nagai, K., and Sasaoka, T., *Jap. J. Genet.*, 5, 151 (1930).

[3] Howard, H. W., *J. Genet.*, 35, 383 (1938).

[4] Catcheside, D. G., *Ann. Bot.*, 48, 601 (1934).

Sulphanilamides and Experimental Tuberculosis

A NUMBER of workers have claimed that sulphanilamide[1], sulphapyridine[2], prontosil soluble[3], and sulphathiazole[4] in high concentrations may modify the course of experimental tuberculosis in guinea pigs. Promin, *p,p'*-diaminodiphenylsulphone-N,N'-didextrose sulphonate, has also been found effective in animal experiments[5]. However, no positive clinical results have been secured with the first-mentioned sulphanilamides, while promin is at present being tested.

It has been claimed that the lack of activity is perhaps partly due to the fact that the sulphanilamides used do not adequately penetrate the lipoid layer of the bacteria; and consequently an attempt has been made to achieve better results by introducing lipophilic radicals into the sulphanilamides. This theory appears reasonable, in view of the fact that *Mycob. tuberculosis* is an acid-fast bacillus rich in lipoids. On this basis, N^1-dodecanoylsulphanilamide has been prepared[6] and tested experimentally, without, however, consistent success[7,8]. Sulphanilamide derivatives of chalmoogric acid—of additional interest since this acid in itself has a certain activity against *Mycob. lepræ*, which is related to the tubercle bacillus—and of other lipophilic acids have also been prepared and tested in animal experiments against leprosy and tuberculosis, but without effect[8]. On the ground that sulphathiazole is considerably more active than sulphanilamide against most of the bacteria investigated, the introduction of a lipophilic substituent in the heterocyclic part of the first-mentioned compound has also been tried. A series of alkyl-sulphathiazoles[9] (amyl, heptyl, nonyl, etc.) as well as several alkyl sulphathiodiazoles[10] have been prepared in order to test them against the tubercle bacillus.

Thus, the results secured so far can scarcely be called uniform. Even if theoretically it would appear that lipoid-solubility should increase the contact between a chemotherapeutically active compound and the tubercle bacillus, this has not been proved. Furthermore, 'lipoid-solubility' is a comprehensive term, and in this case rather specific conditions may be involved. We therefore decided to attempt in other ways to obtain affinity for *Mycob. tuberculosis* while retaining the fat solubility.

The facts that *Mycob. tuberculosis* is able to form compounds of a vitamin K nature[11] and that the closely related *Mycob. paratuberculosis* (Johne's bacillus) requires such substances as growth factors[12], suggested an investigation of the chemotherapeutic effect of sulphanilamides which are substituted with naphthalene derivatives, of the same nature as the antihæmorrhagic compounds (vitamin K activity is found only in the series of 1,4-naphthoquinones or among compounds supposed to be convertible into such quinones in the organism; further, the effect is due to the methyl group at the 2-position; in the 3-position there must be no or only a certain kind of substitution[13]). We therefore synthesized a series of sulphanilamides which at the amido nitrogen, N^1, are substituted in this manner. The following examples may be mentioned: 2-sulphanilamido-1,4-naphthoquinone (1), melting point 227°; 2-methyl-1-sulphanilamidonaphthalene (2), melting point 248°; and 2-methyl-1-hydroxy-4-sulphanilamidonaphthalene (3), which melts with decomposition at 209°. (Further details will be published in the near future.)

The compounds, which are difficult to dissolve in water but more or less soluble in different fat solvents, possess lipophilic qualities in the wide sense of the term. They have been tested *in vitro*—in some cases *in vivo* also, due to the difficulty of dissolving them in water—against pneumococci of types I and III and against *E. coli* and have been compared with sulphanilamide and other compounds. All the compounds showed activity, particularly 1, which has a growth-inhibiting effect of the same magnitude as that of sulphapyridine. Experiments have been instituted to discover whether compounds of this type have any action on the tubercle bacillus. The synthesis of other similar compounds is also being attempted.

Since certain vital dyes have an affinity for *Mycob. tuberculosis*, we have started making substitutions in different sulphanilamides with groups which can be regarded as characteristic of the compounds showing this affinity. The substitution must, however, be done in such a way that the sulphanilamide derivatives fulfil the fundamental conditions for a chemotherapeutic effect. This should be feasible, since these conditions are now rather well understood. If it were possible at the same time—due to the substitution—to obtain an affinity, this might conceivably lead to a better contact. We intend to investigate this question.

BERTIL SJÖGREN.

Central Laboratories,
Astra, Södertälje.
Sept. 2.

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[1] Cf. Rich and Follis, *Bull. Johns Hopkins Hosp.*, **62**, 77 (1938). Greey, Campbell and Culley, *Proc. Soc. Exp. Biol. and Med.*, **39**, 22 (1938). Buttle and Parish, *Brit. Med. J.*, **2**, 776 (1938).

[2] Feldman and Hinshaw, *Proc. Staff Meet., Mayo Clin.*, **14**, 174 (1939).

[3] Birkhaug, *Brit. Med. J.*, **2**, 54 (1939).

[4] Ballon, Guernon and Simon, *Amer. Rev. Tuberculosis*, **45**, 217 (1942).

[5] Hinshaw and Feldman, *J. Amer. Med. Assoc.*, **117**, 1066 (1941). Feldman, Hinshaw and Moses, *Amer. Rev. Tuberculosis*, **45**, 303 (1942).

[6] Grossley, Northey and Hultquist, *J. Amer. Chem. Soc.*, **61**, 2950 (1939). Cf. also Bergmann and Haskelberg, *J. Amer. Chem. Soc.*, **63**, 2243 (1941).

[7] Climenko, *Proc. Soc. Exp. Biol. and Med.*, **43**, 624 (1940). Steinbach and Duca, *ibid.*, **44**, 133 (1940). Muschenheim, Forkner and Duerschner, *ibid.*, **45**, 556 (1940).

[8] Arnold, Helmert, Möbus, Prigge, Rauen and Wagner-Jauregg, *Ber. d. deutsch. Chem. Ges.*, **75**, 369 (1942).

[9] Jensen and Kjaer, *Dansk. Tidskr. Farmaci*, **16**, 110 (1942).

[10] Arnold, *Ber. d. deutsch. Chem. Ges.*, **75**, 87 (1942).

[11] Anderson and Newman, *J. Biol. Chem.*, **103**, 197 (1933). Almquist, Pentler and Mecchi, *Proc. Soc. Exp. Biol. and Med.*, **38**, 336 (1938).

[12] Woolley and McCarter, *Proc. Soc. Exp. Biol. and Med.*, **45**, 357 (1940).

[13] Cf. Fieser and co-workers, *J. Biol. Chem.*, **137**, 659 (1941). Sjögren and Sundberg, *Acta Physiol. Scand.*, **2**, 227 (1941).

The Golden Hamster as a Test Animal for Tubercular Infection

THE bacteriological diagnosis of specimens for presence of Koch's bacilli and testing of compounds for their antitubercular properties are mainly restricted to guinea pigs and rabbits; mice are naturally resistant to tuberculous infections, and lesions produced after injecting massive doses of tubercle cultures differ from those found in susceptible animals. We have now been able to confirm that the Syrian or golden hamster (*Cricetus* (*Mesocricetus*) *auratus* Waterhouse), after intramuscular or intraperitoneal infections with a human or a bovine strain, develops anatomical lesions similar to those seen in guinea pigs.

The lesions produced with doses as small as 0·001 mgm. of a virulent human strain have, after a period of 16–20 days, already developed sufficiently to give post-mortem findings (enlargement of lymphatic nodules close to the place of injection, enlargement of aortic and mesenteric glands, enlargement of spleen, miliary eruptions in liver, kidney and lungs) visible to the naked eye.

Hamsters thus offer considerable advantages in this type of experimental work. Besides being susceptible to infection with Koch's bacilli, they are small animals and are thus more economical of food and space than are rabbits or guinea pigs. Moreover, having an exceptionally short period of gestation and an average litter size similar to that of the rat (7–8 animals), a colony of adequate size can be built up more rapidly than can an equivalent colony of rabbits or guinea pigs; finally, the hamsters available in Great Britain, being highly inbred stock, have a genetic uniformity that makes them specially suitable for biological tests.

J. UNGAR.

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Sept. 25.

Viscosity and Chemical Constitution

SURFACE tension, σ, and viscosity, η, are regarded as manifestations of van der Waals' intermolecular forces of attraction. If, therefore, rise in temperature merely separates the molecules of a liquid, σ should be proportional to $\eta^{\frac{1}{2}}$, since σ is expressed in force units per cm. and η per cm.^{2}. This is approximately true for unassociated liquids over a considerable temperature range from the boiling point downwards.

Replacing $\sigma^{\frac{1}{4}}$ by $\eta^{\frac{1}{8}}$ in Sugden's parachor, gives $M\eta^{\frac{1}{8}}/D = \text{constant} = R$ (say), where M is the molecular weight and D the density. R is of the same order of constancy as the parachor over the above range of temperature and enables us to compare molar volumes of different substances at constant η. R is additive and a constant fraction of the critical volume. Analogous isomerides yield identical values. R thus promises to be a useful instrument for studying the constitution of liquids. By analogy with parachor, the name rheochor (Gk. *rheos*, stream) is suggested. At a later date it is hoped to publish elsewhere a detailed application of this expression.

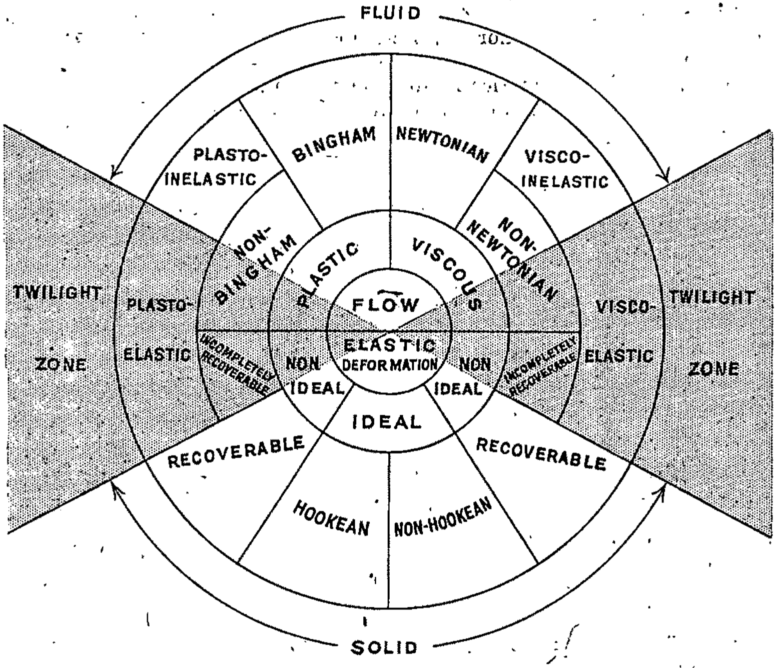
J. NEWTON FRIEND.

Technical College,
Birmingham.
Sept. 25.

A Rheological Chart

FOLLOWING the classification of rheological properties discussed in NATURE of June 20, 1942, p. 702 the following chart is proposed. The chart, which is largely self-explanatory, is based on the scheme of classification proposed by Dr. Treloar and developed by Mr. D. C. Broome and the British Rheologists Club.

Starting in the centre of the chart the properties of matter are divided into the two major groups of flow and elastic deformation. Flow is divided into plastic and viscous types. Plastic flow is further divided into Bingham and non-Bingham, viscous flow into Newtonian and non-Newtonian. Non-Bingham flow is divided into plasto-inelastic and plasto-elastic, the latter overlapping the lower elastic half of the chart. Non-Newtonian flow is divided into visco-inelastic and visco-elastic, the latter also overlapping the lower half of the chart. There is thus seen to be an exact parallel between plastic and viscous properties in themselves and in their relation to the elastic properties of matter.



Elastic deformations are divided into ideal and on-ideal deformations, the latter appearing on both sides of the former in the chart. Ideal deformations are further divided into Hookean and non-Hookean. The non-ideal deformations are divided into recoverable and incompletely recoverable deformations, and the incompletely recoverable further divided into plasto-elastic, overlapping the plastic domain, and visco-elastic, overlapping the viscous domain. The coverable non-ideal elastic deformation is included vice merely to preserve the symmetry of the chart.

It is seen that the fluid properties of matter occupy he upper regions of the chart and the solid properties f matter the lower, while between them on either side a twilight zone exists where solid and fluid roperties subsist together. Ideal properties, therere, lie north and south and real ones east and est.

It is claimed that, whereas the proposed chart embodies no new knowledge, it expresses in a more vid and graphic manner than heretofore the interlation of rheological properties implied in the iginal scheme.

L. BILMES.

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Finchley,
London, N.3.
Aug. 24.

The Public Schools in Great Britain

READERS of NATURE at home and abroad should realize that the letter in the issue of September 19, p. 351, condemning public schools, and also the proposals to open them to boys whose parents cannot at present afford the fees, does not necessarily command the assent of a representative fraction of British scientific opinion. As one of those who did not sign the draft of this letter when circularized, I wish to disagree heartily with its tendentious political tone, which so distorts the aims, achievements and services rendered to the world, of our best public schools, as to present a grossly misleading picture which is likely to bring a valuable feature of British education into discredit with those who have not access to first-hand information.

I have very good reason to know that in the best public schools education is, both in scholarship and in character training, at least as good as anything to be found elsewhere in Great Britain and probably anywhere in the world; so good indeed that many of its features have been successfully adopted by secondary schools here, and by some schools abroad. During my time at one of the best-known, of these schools, though there were few specialists in science, teaching in these subjects was adequate and varied; and in mathematics it was excellent; while the range of reading and excellence of scholarship required of classical boys constituted a broad education such as can be found only very rarely in any country. Though my brother and I had our fees entirely remitted for some years, the idea of our being in any sense in the position of the "poor relation in the family of the rich", or "hostages" to perpetuate the unfair privileges of the wealthy classes, would have seemed so absurd as to merit no attention whatever. The tradition taught was never one of claiming privileges, but of fine scholarship and unselfish service to the community; and these traditions are well maintained at the present time, while the scientific education has improved until it is not excelled anywhere.

I object most strongly to the assertion that the social conscience of public school men is so warped that even their science tends to become an "esoteric cult". The record of achievement, in pure and applied science, of men from public schools, easily discovered by those who take the trouble to consult both scientific journals and such publications as "Who's Who", is very high indeed, despite the fact that until fairly recently the proportion of public school boys taking science seriously was not large. Neither is there any serious lack of good fellowship, nor class distinction, between those scientific men who were at public schools and those who were not.

The fact that the best of these schools produce a larger proportion of leaders in a great many departments of human activity than other types of school is due more to the excellence of the education they afford than to the special privileges of wealth or social position possessed by those who attend these schools. In the absence of prejudgment on the basis of a political creed which seems to regard income levels as the preponderant factor in classifying human beings, and automatically condemns as iniquitous those classes who start with a slightly higher income than others, the natural conclusion to be drawn from the success of men from these schools is that the schools are the best in the country, and is a good reason for continuing and even extending them. It is extremely foolish to begin reform of education by abolishing that type of school which, though not perfect, is at least as good as, and in some ways better than, any other.

It is unfortunately true that entry to public schools is almost entirely restricted to boys in the higher levels of family income, at present. This undemocratic feature has not been present throughout the entire history of these schools, and does not seem to be an essential feature of them. The admission of boys from elementary schools seems the right way to correct this fault. At present, there are considerable difficulties in the transition, partly because the boys destined for secondary education are drawn off from elementary schools some two years before the present normal age of entry to public schools, and the curricula of elementary schools do not lead naturally to those of public schools. These administrative difficulties should not be insuperable, with goodwill on both sides.

It is some decades since Oxford and Cambridge opened their doors widely to boys from all types of school, so that the society in universities is far more democratic than fifty years ago. This has not produced the "psychological dislocation" which the signatories to this letter anticipate; why should mixing of all classes of boys at school age produce this mental disease? It does not, in other countries where boys of all classes mix at school, and should not do so even in our ancient, or modern, public schools. The founders of our oldest public schools did not intend them to be reserved for the wealthy; and there is surely not so much difference in the nature of the boys from poorer and from richer families that they cannot mix! I suspect that what the signatories to this letter really fear is not the effect on the minds of the boys, but the imperilling of the creed that the interests of the richer and poorer classes must for ever clash. I welcome the attempts to throw open our best public schools to boys of all degrees of wealth, both as fulfilling the original intentions of the founders of these schools, and as an important step to the abolition of class distinctions.

N. K. ADAM.

University College,
Southampton.
Sept. 22.

Private Schools in America

THE letter on "The Public Schools in Great Britain" (NATURE, Sept. 19, p. 351), in its references to the system in America, does not show much acquaintance with the American scene.

There are in America half a million pupils in private schools—schools maintained solely by fees and endowments. Even allowing for a population in America three times that of Britain, one may say that this figure of half a million represents proportionately a private-school enrolment in America at least twice as large as the public-school enrolment in Britain.

In neither country, I submit, is the factor of wealth so excluding, so all-pervading, as the signatories of that letter suggest it is in Britain. As in Great Britain numerous scholarships are open to pupils of small means, so they are in America.

An important aim of American private schools is to set a standard of manners—a thing difficult to preserve in an American pupil if he lives in a metropolitan area and has for years to attend a tax-supported school largely populated by children of immigrants. However, American private schools are not divorced from democracy. For example, many of them serve the community in which they are located by offering night courses for adults, or serve the nearest metropolitan district by operating summer camps for city children. In both these activities the senior private-school pupils themselves take part.

WILLARD CONNELY.

American University Union,
1 Gordon Square, W.C.1.

Science and Organization

I READ with much interest the leading article in NATURE of September 12 on the "Organization of Science for War". There are few scientific workers who will not agree with the need for careful planning, both for the conduct of the War and for the urgent problems which must be solved in the post-war years: so far from wishing to criticize this point of view, many have complained, as is noted, of the inadequacy of organization and of the failure to utilize their skill.

But while these views are almost universally held, I believe that many men of science will regret some of the references to those scientific workers who are convinced that there are other considerations of importance. It is unfortunate to suggest that scientists "have spent too much time squabbling among themselves over such questions as to what extent science should be planned", for surely such discussions have in fact occupied few scientists for very little time; in any event, "in the democracy for which we are fighting" we may anticipate that it will not be thought improper for scientific workers who recognize their duties to society to put forward views regarding the extent to which scientific research can advantageously be planned.

While convinced of the need for the planning o co-ordination of research both for the present and for the immediate future, I would suggest that any long-term plan must recognize that, in addition to a main body of directed investigators, there must be the largest possible number of 'free' researchers acting as pioneers in the opening of new spheres of work. For many reasons, it would be desirable tha much of this pioneer activity should be centred, as at present, in the universities.

In this connexion, too, it is to be hoped that those concerned with planning will not overlook the cultural aspects of science: unless art, music an poetry are to be frowned upon, there must surely b a place for scientific work for which no probable utilitarian value can be foreseen.

To many these views will probably be no mor than platitudes, but they are restated briefly in the hope that some confused issues may be clarified.

A. E. TRUEMAN.

University of Glasgow.
Sept. 24.

RESEARCH ITEMS

Marine Fauna of Bristol Channel

IN recent years some very useful information has been compiled from the vertebrate and invertebrate survey of the Bristol Channel which Prof. C. M. Yonge introduced about 1937 and has generally supervised. This biological survey covers chiefly the intertidal fauna of the Severn Estuary and Bristol Channel. Having previously listed fifty-four species of Amphipods, R. Bassindale has recently reviewed the distribution of these animals in the area (*J. Animal Ecol.*, May 1942), *Gammarus zaddachi* being the commonest, occurring in three forms, one of which extends to fresh water, and the salinity ranges of five species of Gammarus and Mariogammus are given and comparisons made with the Tay. Previously, Bassindale had listed (*Proc. Bristol Naturalists' Soc.*, 1940) 3 species of Protozoa, 10 Porifera, 88 Cœlenterata, 3 Platyhelminthes, 1 Nemertine, 1 Chætognath, 33 Annelids, 2 Gephyrea, 235 Arthropods, 134 Molluscs, 68 Polyzoa, 5 Echinodermata and 5 Tunicates, although many species remained to be determined. At the same time A. J. Lloyd listed 111 fishes, including the burbot, sandy ray, flying fish, seahorse and boarfish. L. H. Matthews added a list of 5 Pinnipedia (seals and walrus) and 11 Cetacea. Further notes on the fishes have been given (*Proc. Bristol Naturalists' Soc.*, 1941), and some corrections add the deep sea fish, *Marolicus muelleri* (Gmelin), which has luminous organs. The area covers the Devon, Somerset and Gloucestershire coasts from Ilfracombe to above Gloucester, and the expenses of the survey and publication have been borne by the Colston Research Fund of the University of Bristol. It makes an interesting comparison with the faunal survey of the littoral of the Isle of Man and the Lancashire, Cheshire and North Wales coast by the University of Liverpool biologists over a period of more than fifty years, the survey of the River Tees in 1935 (Tech. Pap. Water Pollut. Res., 5 and 6) and the work on the fauna of the Tamar estuary (*J. Marine Biol. Assoc.*, 23 and 24).

Biology of the Larch-Shoot Moth

BRYAN P. BEIRNE has contributed a paper on the biology and control of this insect, *Argyresthia lævigatella* (*Econ. Proc. Roy. Dublin Soc.*, 130–49; August, 1942). The adult is a small creature measuring 12 mm. across the expanded wings. It ranks as one of the chief enemies of the larch and causes a considerable amount of damage in many parts of Europe. The larva lives internally in the shoots, ultimately causing their death by eating into the wood. No artificial control method can be suggested apart from hand-picking of infested shoots—which would only be possible where the trees are young and few in number. The author concludes from an examination of infested shoots that 77 per cent had the contained larvæ destroyed by natural enemies. Of this percentage insectivorous birds account for 67 per cent, unknown causes 5 per cent, fungi 2 per cent, Nematoda 2 per cent, and Hymenopterous parasites 1 per cent. Of the last-named enemies only one species, the Ichneumonid *Ephialtes elegans*, was bred out, and an illustrated account of its life-cycle is given together with descriptions of the morphology of the early stages.

The Maize Shoot

A COMPREHENSIVE developmental study of the shoot of a complex monocotyledon, such as maize, requires special methods of technique, and in the present study, B. C. Sharman has supplemented the usual anatomical methods by processes of retting, plasmolysis and the utilization of special methods for fixation and staining of cytoplasmic details (*Ann. Bot.*, N.S. 6, 245; 1942). It is brought out very clearly that the growth is articulated, the unit consisting of lamina, sheath, internode, nodal plexus and either a ring of roots or a bud. Within each such unit the main and lateral strands are initiated basifugally, but numerous small strands undergo all their differentiation basipetally, as well as the last protoxylem and all the metaxylem and metaphloem of the main and lateral strands. Where such strands are differentiating in tissue outside their own unit, their development probably comes more under the control of conditions existing in the other unit. It is also evident that in maize, 'file' growth plays a very considerable part; though partially vacuolated, this type of tissue constitutes the so-called intercalary 'meristem' and, so long as not too far differentiated, the cells may return to the meristematic condition as new prodesmogen strands differentiate. The basipetal sequence of development at a time when the lamina is emerging into the light is suggestive that this process is associated with transfer of food materials down into the axis to supply basifugal prodesmogen differentiation of strands destined to run to new leaves forming above, as well as to supply the growth of roots and buds from the node at the base of the unit. These points as well as others, such as the occurrence of periclinal divisions in the dermatogen, the dermal nature of the ligule, the appearance of new strands from file meristem, the debated question of cambial activity in the bundles, etc., are discussed and amply illustrated by very clear line drawings, diagrams and photographs.

Artificial Culture of Plant Embryos

J. van Overbeek, M. E. Conklin and A. F. Blackeslee (*Amer. J. Bot.*, 29, 472; 1942) have had considerable success in culturing embryos of Datura from fruits ten days after pollination. They used dextrose, mineral salts, several physiologically active substances and coco-nut milk. An increase of 500–8,000 times the volume size was obtained in ten days. Viable seedlings could be obtained by transferring the embryos to a medium without coco-nut milk, which inhibits root production. Coco-nut milk contains at least three factors affecting the growth of the embryos: (1) a thermolabile factor controlling growth and differentiation, (2) a thermostable factor causing callus growth and no differentiation, (3) a thermostable factor which inhibits root growth. G. W. Skimm (*J. Hered.*, 33, 211; 1942) was similarly able to increase the viability of embryos in Prunus hybrids. In seventy-six crosses no seedlings were obtained by normal development but they were obtained by artificial cultures. In many other crosses the percentage of seeds which were germinated was considerably raised by artificial culture. Similar phenomena were found in Lilium hybrids. Artificial embryo-culturing largely overcomes the abortion which occurs at different stages of embryo development in hybrids.

Elastic Constants of Metal Crystals

A THEORETICAL treatment of the elastic constants of metal crystals is given by K. Fuchs and H. W. Peng (*Proc. Roy. Soc.*, A, 140, 451; 1942). The approximate equations of motion for the electrons in a cyclic lattice of a metal are set up with the help of the self-consistent field. The displacements of the ions are then considered as perturbations of the motions of the electrons. The change of the boundary is compensated by a co-ordinate transformation. The change of the potential energy of the lattice due to homogeneous deformation is calculated by the perturbation method. The calculated values of the elastic constants are found to be in satisfactory agreement with the observed values.

Dynamics of a Spinning Top

AT the meeting of the British Astronomical Association, held at Zion College on August 26, J. Miller showed some experiments with a spinning top which seemed to controvert the usually accepted views regarding the rising of tops (*J. Brit. Astro. Assoc.*, **52**, 250; Sept. 8, 1942). It is laid down as a principle in text-books that, if the precession is hurried up, the top rises—a principle with which Miller agreed—but he traversed the additional law that friction is responsible for hurrying on the precession. He showed an electric motor, specially designed by him for experiments with rotating bodies, in which the vertical axis of a rapidly rotating spindle is hollowed in such a way that the toe of a top can rest in it while spinning. When the spindle is made to rotate by an electric drive, and a top, which has been given a spin in the same sense as the rotating spindle, but with a smaller angular velocity, is placed on it, the top precesses just in the same way as it does when the current is cut off and the spindle is at rest. In accordance with the usually accepted view that the friction between the toe and the point of support is responsible for hurrying on the precession, there should have been an alteration in the sense of the precession, because frictional effects had been reversed in direction. Miller suggested that some of the mathematical theories should be subjected to crucial tests before they are accepted as explanations of various phenomena to which we have become accustomed, but for the exposition of which theory is sometimes at fault.

Rotating Sectors in Stellar Photometry

DONALD A. MACRAE discusses a new technique in photometry—a rotating sector (*Sky and Telescope*, August). In the accurate determination of the magnitudes of stars, it is important to be able to reduce a star's light by a known fraction, and this can be accomplished by placing in the beam a small disk from which a sector has been removed. When the disk is set rotating during exposure, the star's light is reduced in the ratio of the open to the solid part of the disk. A difficulty arises over the *reciprocity failure*, which implies that the emulsion does not react in the same way that it would to a constant light of the reduced intensity. Research in the laboratory has shown that the difficulty can be overcome by rotating the sector fast enough, and when the rotation rate exceeds 4,000 rev. an hour, the plate will react as it should. No systematic errors will arise in the 'magnitude scale' set up by this new method. L. F. Barcus, of the Sproul Observatory, shows the application of the rotating sector in another field. As is well known, the relative positions of two stars can be measured more accurately by photographic methods if they are nearly of the same brightness. As this is seldom the case, sectors are used to reduce the brightest star. Mr. Barcus describes the difficulties which must be overcome in cutting and mounting a set of sectors giving reduction factors from a few tenths to several magnitudes.

Cyanogen Criterion of Absolute Magnitude

CYANOGEN is a common constituent in interstellar space, in comets and in the atmospheres of some stars. The true luminosity or absolute magnitude of stars having temperatures comparable to that of our sun has been found from the apparent conspicuousness of cyanogen in their spectra, but the results have not always proved reliable. Dorrit Hoffleit, at Harvard, has recently utilized new available material on the proper motions of the stars to test the validity of the application by F. Becker of the cyanogen criterion to stars in the −45° zone (*Sky and Telescope*, August). He found that accurate measurements of cyanogen line intensities on standardized plates of good quality yield absolute magnitudes superior to estimates based on spectral class alone. On the other hand, simple eye estimates on unstandardized objective-prism plates of faint stars are not necessarily adequate in determining whether a star is of high luminosity. Stars identified by Becker as giants are practically always true giants, but those provisionally assumed to be dwarfs are often erroneously classified as such, according to Dr. Hoffleit.

Orbital Variable Stars

IN a paper with this title (*J. Brit. Astro. Assoc.*, **52**, Sept. 8, 1942), P. M. Ryves deals with a number of divisions under which orbital variable stars may be included. Tidal effect is a factor which arises out of the close proximity of two stars. Gravity acting on the surface of the companion is responsible for a disturbance which implies greater brightness on the nearer portion, and each star will appear to vary in a period equal to that of the revolution, unless they are viewed from the pole of the orbit. If the components are equal, the variations will cancel out, but if they are unequal the tidal effect shows up in the light-curve. Another way in which a binary may appear to vary is through the effect of the radiation of one star on the other, and this may be greatly enhanced when the components are close. While there are no cases of stars varying from radiation effect alone, it is possible that some may be discovered by future research among spectroscopic binaries. Another way in which variation of light occurs is due to ellipticity, and a few such stars have been detected. A closely connected pair will be subjected to a strong gravitational field and will assume an ellipsoidal shape. In cases where they are viewed broadside on, they will present a larger surface and will send us more light than when they are seen end on. The light from such a pair will not vary intermittently, like Algol, but continuously, the period of light-variation being equal to half the revolution period. The character of the variation will be of the sine-curve variety, similar to a symmetrical Cepheid, like η Geminorum. Among the other classes may be noticed ellipticity combined with eclipse, and when such occurs we have the W Ursæ Majoris class if the components are equal, and the β Lyræ class if they are unequal. Under eclipses alone is included the well-known Algol class.

LOCATION OF INDUSTRY ON MERSEYSIDE

THE Social Science Department of the University of Liverpool continues to carry on its invaluable work in war-time, and in the latest volume in the New Merseyside Series, the Statistics Division has made an important contribution to the local planning which must be undertaken within the scope of national planning principle. "The Distribution of Population and the Location of Industry on Merseyside", by W. Smith (Liverpool: University Press of Liverpool. 5*s*. net.), gives a clear and carefully drawn picture of the industrial features of the area as they were on the eve of the War. Mr. Smith indicates the elements of change as well as of stability, and this admirable analysis of the industrial and social pattern of Merseyside should stimulate research workers in other areas to bring up to date, so far as possible, parallel investigations in their own areas, in order to provide the factual basis for any detailed attempt to plan the post-war location of industry.

Analysing first the distribution of population, Mr. Smith points out that differential age-composition may be dismissed as definitely not responsible for the higher birth-rate of Merseyside and that the population of Merseyside would grow naturally and continuously if no other factor intervened. Since 1927 the migration curve of Merseyside, which has consistently shown an annual net exodus, has varied with the state of trade in Britain, increasing when industry and trade have been active and falling away when they have been sluggish. In regard to the local distribution of population on Merseyside, Liverpool, Bootle and Birkenhead exhibit comparable trends. Bebington, Crosby, Hoylake, Ellesmere Port and Wirral all show, after adjustments have been made for changes in boundaries, continuous inward balances of migration, while Huyton and West Lancashire both exhibited an outward migration balance prior to the War of 1914–18. The core of Merseyside is an area of high natural increase but, since 1927, of large outward migration balance and of declining population, while the margin is an area of lower natural increase, in places of natural deficit, but of large inward migration balance and of increasing population.

In regard to the location of industry, Mr. Smith points out that throughout the period 1924–39 Merseyside had less than its share of employment and more than its share of unemployment, the gap tending to increase during the period up to 1937–38 and markedly decreasing in 1938. There was a substantial recovery in the employment position on Merseyside on the eve of the War, but insufficient to make good completely the ground lost in the preceding years. Analysing the industrial character of Merseyside, it is noted that metals and engineering, other manufacturing industries and 'other services' have fluctuated widely, and these groups occupy a relatively larger place in the economy of Merseyside in times of boom and a relatively smaller place in times of depression. The reverse is true of food, drink and tobacco, and textiles and clothing, which show little fluctuation in numbers, while with regard to transport and distribution, which exhibit movements independent of the trade cycle, it appears that insured workers flock into the distributive trades in times of industrial depression and abandon them in times of industrial prosperity.

The industrial structure of Merseyside is thus not wholly static, and Merseyside presents a different industrial structure from Great Britain as a whole both in nature of industry and in size of factory. In proportion to its total employment, Merseyside has a relatively large share of large factories. Analysis of the location of individual industries, which occupies the longest chapter of the report, leads to a discussion of the general factors affecting the location of industry on Merseyside, in which it is pointed out that industries which are highly localized on Merseyside almost all depend directly on imported materials, and the primary industries have a higher location factor than the secondary products derived from them. Moreover, Merseyside has few industries using primary materials produced within Britain, and where such materials are used it is in smaller quantities than imported materials. The pull of Merseyside on industrial location in respect of materials is chiefly bound up with the materials imported through the Port of Liverpool, those of low value in proportion to weight feeling the pull most strongly.

In respect of labour, the pull of Merseyside on industrial location affects chiefly those industries requiring labour in quantity irrespective of skill, and Mr. Smith notes that the requirements of skilled labour appears to be of decreasing importance in Great Britain as a determinant of industrial location, quantity rather than quality of labour being of significance. In regard to mobility and immobility, seed crushing, grain milling and sugar refining stand out clearly from the rest in every respect as essentially immobile. Cattle, dog and poultry foods, and to a lesser extent galvanized sheets, approach this group, while the most mobile of the industries considered are matches, telegraph and telephone apparatus, tobacco and aircraft. The major seat of industry within Merseyside is the dock and water-front zone, where all immobile industries are focused, as well as shipbuilding and repairing, constructional engineering and newsprint manufacture, all of which offer mainly male employment. In the extra-dock zone the industries show in the aggregate greater mobility and frequently provide more female than male employment.

In the third part of the report, discussing the future of population and industry in the area, the importance of such studies as providing the factual basis in reconstruction planning is well illustrated. The future magnitude of the population of Merseyside may be said to depend on the rate of natural increase—which on the whole was steady for the five years preceding the War, the extent of war casualties and of the maintenance of the armed forces after the War, the permanence of war-time evacuation and the extent of industrial migration. The future local distribution of population on Merseyside may be presumed to show a continuation or intensification of movements in progress immediately before the outbreak of the War. The future volume of industrial employment on Merseyside is likely to be profoundly affected by the trade of the Port. While the import of food through the Port of Liverpool is likely to be maintained and is unlikely to be greatly affected by changes in British agriculture, restrictions in the world's markets open to Britain are likely to have much more profound effects.

In commenting on possible dispersal of industry from the point of view of defence, Mr. Smith states that while a large agglomeration of factories is presumably an easier target for air attack than a wide scatter of factories over the countryside, the defence of a group of factories may be an easier problem than the defence of widely scattered units. Merseyside has claims to correct deficiencies in the provision of greater opportunities for skilled male employment and for a greater number of the new 'assembly' industries. For correct industrial balance, Merseyside needs more opportunities for skilled craftsmen, and there are many industries of this type possessing considerable mobility which might be directed to Merseyside if the central government contemplates control of industrial location. Such industries should be directed to the extra-dock zone, where the working conditions are better, where the product of a foodstuff can be made under more hygienic conditions and where labour lives within easier access of the factory. Moreover, as regards the industrial satellite in the Merseyside area, if it is not to drain life from its parent, its success appears to depend on the attraction of new industries from outside Merseyside altogether.'

There can be no two opinions as to the value of studies which bring out as clearly for other districts as this one does for Merseyside the factors which determine the volume of employment and local prosperity and well-being, and in their absence it can scarcely be maintained that local authorities are in possession of the knowledge which should be the foundation of their planning. Mr. Smith's report provides an admirable example of the way in which scientific method and investigation can contribute to the solution of major problems in a democratic society.

AUTOMATIC PRODUCTION OF OSCILLATOR SCALES

THE frequency of an oscillator is usually set by dial adjustments corresponding to a calibration chart from which the exact frequency corresponding to the dial indications may be obtained. The relationships between the frequency and dial markings, moreover, are different for every oscillator, so that a calibration chart must be prepared for each. This is not particularly difficult but is laborious, by reason of the need to refer for every reading to a calibration chart. It is much simpler to employ a dial marked directly in frequencies, but to provide such a scale by usual methods requires much time and labour when the frequency range is large and the accuracy is to be high. Although the scales for different oscillators are similar, they are not sufficiently alike to permit the scales for all oscillators to be printed from a single master film.

A method of printing such scales has, however, been recently developed and has been described by T. Slonczewski (*Bell Lab. Rec.*, 20, No. 11, July, 1942). A master scale A is used which, when placed over an unexposed film B, is moved with respect to B at a varying rate, such that at each 50-cycle point a line on scale A will be directly over its correct position on scale B. The section of film B is exposed at the instant it is under the corresponding line on film A. Two oscillators are used, set up facing each other, one serving as the standard and having an accurately marked film scale. The other, to be calibrated, carries on its sprocket the unexposed film that is to be marked, line by line, from the film of the standard, although the spacing of the lines will be different from the standard.

The condenser-driving spindle of each oscillator carries a worm-driven driving gear and film sprocket. For the duration of the calibration, 60-cycle synchronous motors are attached to the condenser worms of each oscillator. A standard motion-picture lamp is mounted behind the film of the standard, and a condensing lens focuses its rays in a narrow band over the section opposite the hair lines where the scale is read. The test oscillator motor receives its supply from the commercial 60-cycle supply. That on the standard is driven by a 'difference' frequency from the output of a modulator to which the output of the two oscillators is fed. When the two oscillators are 60 cycles apart, this latter motor will therefore have a 60-cycle supply, and the two films will be running at the same speed. As each line on the standard film passes through the band of light, it will be printed on the film of the test oscillator. The purpose of this drive arrangement is to vary the speed of the standard film in such a way that the line in the light beam corresponds to the frequency of the test oscillator except for the 60-cycle difference This 60-cycle constant difference is readily corrected after calibration by the low-frequency adjustmen that has been provided for this purpose.

EARTHED-PLATE AMPLIFIER FOR THE FREQUENCY-MODULATION TRANSMITTER

IN the United States, frequency-modulation ha been assigned the wave band 42–50 m.c and a these frequencies, simplification in design and reduction in size of transmitters are of particular importance because of lead reactances and stray capacitances to earth, which increase with frequenc and with size, and may become serious obstacles i large transmitters operating at high frequencies.

A 10-kw. transmitter has been developed recentl by the Bell Laboratories in which the difficultie have been overcome using the new Western Electri 389 *AA*, air-cooled valve, and by a novel circui arrangement due to W. H. Doherty. Even with thi new tube, however, it was found that there woul be sufficient stray plate-earth capacitance to resul in a rather large loss in the plate-tuning coil, and—of even greater importance—the tuning would b undesirably sharp.

Both these obstacles were overcome by the use an earthed-plate amplifier and a number of nov features described by A. A. Skene (*Bell Lab. Rec* 20, No. 11, July, 1942). The circuit employed resul in the stray plate capacitance-to-earth being i parallel with the plate-earthing condenser, which used to provide a radio-frequency path to eart while blocking the D.C., and thus has no effect o the operation of the plate circuit. Only the filamen to-earth capacitance remains and is very muc smaller than the plate-to-earth capacitance. Th filament is at a high radio-frequency potential, a it is very necessary to supply filament current witho operating the filament transformer at this hig potential above earth. It is also necessary to supp radio-frequency driving potential between the gr and filament from the driver unit, one side of whi is earthed.

An ingenious arrangement is described whi achieves these objectives. The normal plate-tuni coil is replaced in the new circuit by a coil betwe filament and earth, and is formed of a pair of copp tubes wound in parallel. The filament leads are threaded through the bore of one of the tubes and the grid-driving potential is supplied through an inner conductor of the other. At the filament end of the coil, each side of the filament is connected to the tubes via a condenser, the other end of the coil being earthed. Thus the filament current and grid-driving voltage are delivered at the required location with the driver and filament transformers maintained at earth potential. The article describes and illustrates the apparatus in some detail.

ISO-MAGNETIC CHARTS OF THE GLOBE

IN a series of articles which have appeared in issues of the quarterly journal *Terrestrial Magnetism and Atmospheric Electricity* (commencing with the issue dated December, 1940), Prof. Sydney Chapman gives the results of his valuable investigation of the general form which iso-magnetic curves should take on magnetic charts of the globe, and of the interrelation between the curves for certain components of the earth's magnetic field.

The magnetism of the globe assumed in the first-named investigation is that due to a 'dipole' centred upon an axis of the earth. Although this simplification only roughly corresponds to observed facts, and although in a generalized discussion local irregularities of the earth's field cannot, of course, be aken into account, some interesting and instructive geometrical features are shown to exist, knowledge of which can be applied with advantage in the construction of magnetic charts. Examples are: the hape of the curves near their nodes and singular points, the correspondence and relation of nodes and loci, and the course of the iso-lines near the magnetic or dip) poles.

In the second branch of his investigation, Prof. Chapman develops and demonstrates a method of esting the mutual consistency of data derived from so-magnetic charts of declination and horizontal intensity. Normally, the charts are produced independently. The line-integral of the magnetic force round a closed contour on the earth's surface can be used to calculate the intensity of current electricity passing between atmosphere and earth within the boundary. Direct measurement of air-earth current, however, shows that the current is actually much too small to be effective on the scale of the charts; and if significant values are obtained when the line-integral is taken, derived from chart readings of declination and horizontal intensity, round a vanishingly small area, the inference to be drawn is that errors exist in the data. These may originate in either of the charts or in both, and will probably be due to actual errors in the placing of the iso-lines y the chart constructor. In this case the position of such lines may be improved by trial even in the absence of fresh data; and since horizontal intensity in general less well determined than declination, substantial improvement in charts of horizontal intensity may be possible by this means.

Prof. Chapman has recently extended his investigation to isopors representing *secular change* in the values of the elements, a problem of considerably greater complexity. The results are published as otes VII and VIII of the series, in the issue of *errestrial Magnetism* of June, 1942.

Isoporic curves, more particularly over the oceans, are to a large extent inferential, since with the sources at present in existence for procuring observational data they are of necessity based on unevenly scattered and relatively scanty information, very largely obtained from fixed land observatories.

Secular change in the earth's magnetic field is itself subject to change which is sometimes quite rapid in limited areas. Consequently, a complete picture of the changes occurring over the whole globe at any one time must always be an ideal attainable only in retrospect.

The lack of mutual consistency detected by Prof. Chapman in areas on the charts he has examined emphasizes the need of additional observations of secular change in particular regions of the globe.

W. M. WITCHELL.

PUTREFACTION IN CATTLE HIDES

THE best method of drying hides is to lace them flat in a frame and dry them with access of air to both sides. Some delay between flaying and the suspension of the hide for drying is inevitable. Commercial practice has allowed this delay to extend to several hours, sometimes to 1–2 days. Experiments were therefore carried out at Kano in Nigeria and at Isiolo and Mombasa in Kenya ("Results of Delayed Drying Trials in Nigeria and Kenya", *Bull. Imperial Institute*, 40, No. 2; 1942). These three places represent a series of conditions of increasing atmospheric humidity and, to a less degree, increasing mean shade temperature, Kano having considerably the driest and slightly the coolest mean shade temperature and Mombasa the wettest and warmest.

In the experiment at Kano the hides were divided into two lots; one lot was given an arsenical dip immediately after flaying, the other lot was given an arsenical dip at the end of the delay period. Arsenical dips, if sufficiently strong, have some bactericidal effect. During the delay period the hides were folded hair out and left in the sun. Drying was in the sun. The dried hides were shipped to England and tanned for sole leather. The hides arsenicated before delay from the 8- and 16-hour periods showed no grain damage. Hides arsenicated before delay but left for longer periods and hides arsenicated after delay all showed slight grain damage in the finished leather. Except for this superficial damage the hides all proved to be sound. There was no damage due to Dermestes beetles.

In the experiments at Isiolo and Mombasa the experimental hides were divided in the line of the backbone, one side suspended for drying within two hours of flaying, the other folded and put in the sun for delay periods up to thirty-two hours. Drying was in the sun. In these hides there was a striking difference between the control and those with delayed drying. All the control half-hides were perfectly sound; the delay half-hides showed varying degrees of putrefaction, worse in the Mombasa hides than the Isiolo hides and increasing with the length of delay. All the control hides were free from damage by Dermestes beetles; the delay hides showed considerable damage both on the grain and in the carium, increasing with the degree of putrefaction. It should be noted that delay and control half-hides were shipped in the same bale. Although considerable putrefaction occurred in some cases it is interesting that the effect on the hide was strictly local. Sole leather from the damaged hides compared with sole leather from the control hides gives similar figures as regards resistance to abrasion, apparent density and water absorption. Nevertheless, it was proved that delay between flaying and drying causes considerable putrefactive damage, especially in a humid climate. D. JORDAN LLOYD.

FORESTRY IN ASSAM

ASSAM is still one of the most undeveloped provinces of India, in spite of the long period it has been under British Administration. This is in the main due to the considerable area occupied by the hill districts inhabited by various tribes whose chief method of livelihood is by the practice of shifting cultivation, that most wasteful of agricultural methods. The backward condition of these peoples must be attributed to the guiding rule of British administration that the customs of the people should not be interfered with, once tribal warfare and other practices incompatible with modern ideas had been stopped. The consequence is that, in spite of the lapse of well over half a century since forest conservation began to be introduced into parts of Assam, forest reservation has made little progress in the hill districts. Even in the Lushai Hills, we read in the "Report of Forest Administration in the Province of Assam for the year 1940–41", by C. Mackarness, Senior Conservator of Forests (Shillong, Assam Govt. Press, 1941) "A Forest Regulation has been proposed and a draft submitted to Government which in a modified form has been forwarded to the Governor-General in Council for assent." The report on this subject continues: "The hill districts of Assam possess an inadequate proportion of Reserved or Protected forests which provides one reason for erosion and flood damage." It may be asked, it is being asked with increasing pertinence, when will the Governments of the British Commonwealth of Nations—for the matter is equally urgent in many of them—face up to this question of the enormous damage and waste which is increasing annually through deforestation erosion and flood damage. It may be that the War may prove the salvation of these Assam hill districts, since it would seem apparent that for military purposes communications are being opened up in what has heretofore been a wild mass of more or less inaccessible hill tracts.

Another factor on which evidence is forthcoming in this report is the want of collaboration between the Agricultural and Forestry Departments, no new thing unfortunately in the Empire, as recent reports have shown here in Great Britain. In spite of the vigorous opposition of the Assam Department a part of the Jamira forest has been disforested for permanent cultivation. It has since been found that this is impossible owing to the hilly configuration, as has been pointed out by the forest officers and since confirmed by the settlement operations. To the Forest Department will fall the task of endeavouring to reafforest the area. The Government policy vis-à-vis the large area of so-called Unclassed Forests in which no reservations have been made appears to be dangerously vacillating, in spite of the fact that a considerable proportion of the forest revenue comes from these large tracts amounting to some 16,000 sq. miles, and that protection for some of the area must be of vital importance to the country as a whole.

An item in the report of interest to those who have studied the question of the preservation of the fauna of India and elsewhere is the reservation of a considerable tract of forest as a sanctuary for wild buffalo in North Lakhimpur. Assam was an early leader in India in the formation of such sanctuaries, the first being for rhinoceros.

The report merits careful study; it includes special notes on the work of the departmental research officers. It is also a model which might be followed, for it includes a number of excellent photographs depicting various forestry operations and also three pictures taken by honorary forest officers in game sanctuaries of wild buffalo, sambhar and—a striking portrait—of a tiger advancing in the jungle towards the spectator.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk is open to the public*)

Monday, October 12

INSTITUTE OF PHYSICS (at the Royal Institution, 21 Albemarl Street, London, W.1), at 10.30 a.m.—Discussion on "The Educatio of a Physicist"; at 2 p.m.—Discussion on "Training for Researc in Industrial and Applied Physics".

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE SECTION) (under th auspices of the Chemical Society, Leeds Area Local Section, in th Chemistry Lecture Theatre, The University, Leeds), at 6.30 p.m.— Dr. F. Fairbrother: "Radioactive Isotopic Indicators".

Tuesday, October 13

CHEMICAL ENGINEERING GROUP OF THE SOCIETY OF CHEMICA INDUSTRY (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, Londo W.1), at 2.30 p.m.—Mr. E. F. MacTaggart: "The Production Radium".

INSTITUTE OF FUEL (at the Institution of Electrical Engineer Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.— Mr. W. M. Selvey: Presidential Address. Dr. Arno Carl Fieldner "The Analysis and Testing of Coal in relation to its Properties an Utilization" (Melchett Lecture).

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lightin Service Bureau, 2 Savoy Hill, London, W.C.2), at 5 p.m.—Mr. R. Ackerley: "Seeing is Believing" (Presidential address).

Wednesday, October 14

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (at the Chemic Society, Burlington House, Piccadilly, London, W.1), at 2.15 p.m.— Dr. Magnus Pyke: "Vitamin Content of Certain Vegetables"; M A. J. Curtin Crosbie: "New Beer Disease Organisms"; Mr. Alan Ward: "Location of Vitamin-B_1 in Wheat".

Friday, October 16

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDE (at the Literary and Philosophical Society, Newcastle-upon-Tyne), 6 p.m.—Annual General Meeting. Mr. J. Ramsay Gebbie: Presidenti Address.

Saturday, October 17

NUTRITION SOCIETY (at the London School of Hygiene and Tropic Medicine, Keppel Street, London, W.C.1), at 11 a.m. and 2.15 p.m.— Conference on "Trace Elements in relation to Health".

Sunday, October 18

ASSOCIATION OF SCIENTIFIC WORKERS (SOUTH WALES AREA) (the Royal Hotel, Cardiff), at 10 a.m.—Conference on "Science Victory".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on before the dates mentioned:

LECTURER IN MECHANICAL OR ELECTRICAL ENGINEERING in t Cannock Chase Mining College—The Director (H), County Educati Offices, Stafford (October 14).

GAS ENGINEER and MANAGER of the County Borough of Warringt Gas Undertaking—The Town Clerk, Town Hall, Warrington (endors 'Engineer and Manager') (October 16).

ASSISTANT AGRICULTURAL ORGANIZER to the Holland County Coun Agricultural Education Committee—The Principal, Agricultu Institute, Kirton, Boston, Lincs. (October 17).

TEACHER FOR DAY AND EVENING ENGINEERING CLASSES—T Principal, County Technical College, Gainsborough, Lincs.

WOMAN LECTURER IN PHYSIOLOGY—The Principal, Liverp Physical Training College, Barkhill Road, Liverpool 17.

LECTURER IN ENGINEERING at the Achimota College, Gold Coast The Secretary, Overseas Manpower Committee (Ref. 391), Ministry Labour and National Service, Hanway House, Red Lion Squa London, W.C.1.

NATURE

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THE ENGLISH COUNTRYSIDE

THE report of the Scott Committee on Land Utilisation in Rural Areas completes the work begun by the Royal Commission on the Distribution of the Industrial Population, the terms of reference of which excluded the consideration of agriculture ; and although its major and minor recommendations are sometimes rather confusingly blended, the report is clearly a reconstruction paper of the first importance. It has life and colour and gives substance to some of those aspirations for an ampler and more satisfying national life which the War has accentuated. Moreover, like the interim report of the Uthwatt Committee, it reiterates the importance of immediate action. A survey of the report appears on p. 448.

Broadly speaking, the Scott report, like that of the Barlow Commission, centres upon two main recommendations : first, that there should be national long-term planning for industry and for agriculture in England and Wales ; and secondly, that for that purpose a national planning authority should be set up. Both principles have been restated by the Uthwatt Committee in its report, and the Government has repeatedly announced its adherence to these views and declared its intention to establish the requisite planning authority. The Scott report should dispose of whatever hesitation has been responsible for the protracted delay in bringing intention to performance. The final argument is convincing : "It is our firm belief that a vital incentive to the war effort is the presentation of a clear picture of a better world which lies ahead and which, if plans are drawn up and the essential preparations made in advance, can be achieved after this struggle is over. To delay planning and the legislation to carry the plans into effect until the time for action is upon us—the end of the war—we believe to be a fatal error."

That is the fundamental conviction behind all the pressure for planning for reconstruction both nationally and internationally, and the case for immediate planning could scarcely have been put better than by the Scott Committee.

This conclusion is reinforced by the melancholy record of the effects of the Town and Country Planning Act, 1932, and the Restriction of Ribbon Development Act, 1935, reviewed in the sixth chapter of the report, which deals with planning powers. This is a striking illustration of the futility of any piecemeal attack on the problem. Despite its complexity it must be tackled as a whole, though strangely enough, there are matters in which the majority report consistently fails to do so—notably in regard to agriculture.

The poor equipment which Great Britain possesses at the moment for dealing with the most pressing tasks in this field gives special interest and importance to the recommendations of the report in regard to machinery. Here the Committee, assuming that the policy of the Government involves the establishment of a Central Planning Authority, proposes that machinery should be set up now to make plans for the use of land, and that the necessary legislation should be passed so that the plans can be put into operation immediately on the cessation of hostilities. The report outlines a definite scheme of work to be accomplished in five years, and it distinguishes carefully between planning and development—between the formulation of a national plan and its execution.

Planning, the Committee considers, should be the function of the planning body within the Government, and development the concern of the separate Ministries. Moreover, despite insistence on a Central Planning Authority, the Committee does not regard its recommendations as involving any specific form of Government machinery. In fact, it considers that the establishment of a separate Ministry of Planning is undesirable and that it is impossible to visualize a Central Planning Authority taking over the execution of planning proposals or any other form of development in those spheres which are the direct concern of existing Ministries. The proposals involve a transfer from the Ministry of Works and Planning, as constituted under the recent Act, of all planning functions, in order to separate them from the development functions of that Ministry.

As to the machinery, the Committee appears to be unanimous. When we come to the general character of our future policy and the aims that should guide our plans, there are serious differences of opinion between the majority report and the minority report signed by Prof. S. R. Dennison. On many questions there is indeed agreement, for example, in regard to the restoration of the village crafts and the improvement of rural life, but Prof. Dennison in his minority report puts forward an entirely different outlook and perspective, and his criticism is both trenchant and fundamental. The question he raises as to the relative efficiency in use of our resources is the one which gives the report a major claim on the attention of scientific workers.

In their introduction the majority, while endeavouring to evaluate and assess the significance of the permanent physical factors in the shaping of the countryside, have sought to avoid the temptation of looking back to the past and seeking to perpetuate it, and in their recommendations they clearly seek to look forward and to visualize many changes. They recognize that British agriculture, however vital to the nation in time of war, cannot be maintained in the same position in time of peace. The conditions to be imposed on constructional development in the countryside must be such as will be consistent with the maintenance of a prosperous and progressive agriculture. The Committee is mindful, too, that the pre-war prevalence of malnutritional disease must never again be allowed to recur.

The gravamen of Prof. Dennison's criticism is that, while facing change, the majority are afraid of it; they are excessively tender to the general body of agricultural interests, allowing it too large a say in matters which concern the nation as a whole. He disputes entirely, for example, the whole idea on which is based the recommendation of the majority that land which is included in one of the categories of good land should not be alienated from its present use unless it can be clearly shown that, on balance, it is in the national interest that the change should be made; he would throw the onus of proof not on the applicant who seeks to make the change, but on the agricultural occupier or interest, who should be required to show cause why land should not be diverted to some other use. In this way, he argues that, using the machinery of planning control, while the best land would not be unnecessarily alienated from agriculture, constitutional development would not be hindered by the maintenance of land for agriculture unless a clear case of national advantage were established.

Prof. Dennison maintains that the majority are inclined to treat village life and agriculture too much as if they were museum pieces and to preserve them by methods which threaten the standard of life both of the villages and of the nation. Fear of the disturbing effects of the introduction of industries to the countryside leads his colleagues, in his view, to overlook the advantages they would bestow. Moreover while evidence was submitted that changes in agriculture may well result owing to national nutritiona needs, the bare fact is noted in the majority report and it is left to Prof. Dennison to elaborate the point His observations on the probable effect of the new ideas of nutrition and protective foods on agriculture is only one example of the way in which his minority report gives precision and incisiveness to a documen which, despite many admirable features, is somewha discursive and vague, and lacks the lucidity of th Barlow Commission's report.

The difficulty—and the differences between the majority and the minority reports—arises in the interpretation of what is meant by "the maintenance of a prosperous agriculture", "the well-being of rural communities" and "the preservation of rural amenities". In regard to the first, Prof. Dennison bases his argument on economic considerations an the relation of the maintenance of agriculture to th standard of life of the rural worker. Both the exten and the type of agriculture are involved, and althoug recent reports from the industrial side dealing wit reconstruction recognize the importance of a correc balance between industry and agriculture, th majority report carries the analysis little furthe Prof. Dennison considers that the assumptions the majority report would only provide bett standards of life for the rural worker at the expens of the community.

In a progressive society, the ultimate prosperit of agriculture must depend upon increased efficiency but this is not necessarily achieved by increase output. Greater specialization may also be importan particularly in regard to improved nutrition. Th depends upon the type of food as well as on quantit involving more vegetables, milk and other protecti foods which traditional agriculture in England ar Wales has never supplied in adequate amounts; an as Prof. Dennison rightly points out, the needs of th consumer as well as the quality of the land mu determine what shall be grown. The aims of ag cultural policy in Great Britain should be, as Viscou

Astor and Mr. Rowntree put it, "to promote a happy marriage between nutrition and agriculture rather than to shut out overseas competition, to improve the conditions of the agricultural labourers rather than to increase their numbers, to treat agriculture as an industry or group of industries . . . existing for the purpose of satisfying human wants with the minimum of toil, rather than as a way of life to be preserved with the minimum of change".

The essential point in determining the type and size of agriculture is that the full measure of economic progress, the improvement of standards of living, can take place only if, as technique and economic conditions change, resources are no longer deliberately impeded in their movement from uses which yield a small return of goods to those which yield a larger return. To attempt to retain resources in any existing form of activity which gives a lower product than others, which are new and developing, must involve a loss to the community in general, in that standards of life as a whole are kept down. What has to be remembered is that, as Prof. Dennison again points out, for many types of produce we can obtain more food by employing labour and capital in manufacturing goods which are exported, and importing food in return, than we can by using the same amount of labour and real capital in agriculture to produce the food directly. This is one of the recognized advantages that Great Britain has over Germany, and the answer to the argument that a large agriculture must be maintained for purposes of security in time of war. The need is not denied, but it will not be achieved by methods which are wasteful of man-power in war as well as in peace. Malnutrition will not be conquered by growing more food at great cost, but by cheap food, obtained with the minimum expenditure of resources.

Social policy might well be directed to increasing the demand for the protective foods—for example, milk—so as to cushion any fall in the agricultural output in other directions, and this is a legitimate contribution to the well-being of rural communities which is not at the expense of the whole community. Prof. Dennison, however, differs from the majority of his colleagues in holding that the rural community, if it has lower standards as a result of lower wages in agriculture, should not be protected from the impact of higher standards. While supporting such recommendations for the improvement of rural life as spreading village colleges like those now established in Cambridgeshire, village halls, village playing-fields, and the universal supply of electricity, he holds that the introduction of a certain degree of industrial development offers the best hope of improving the social and economic conditions in the countryside. The two main advantages are the provision of alternative employment, usually with higher standards of living, and the introduction of improved physical and social services.

In regard to the preservation of amenities, Prof. Dennison challenges the majority view that amenities depend on farming, or even on a particular type of agriculture. Changes in the type of farming and the development of physical reconstruction may bring changes in the countryside, but there is no reason why they should not create greater amenity than existed before. It is in fact difficult to conceive of a more fitting way to use land in the national interest than to use it for the new construction necessary to provide better living conditions for the people—and their children after them—now dwelling in congested towns. In particular, it is important not to attempt to preserve amenities which can only be preserved as long as full access to them is denied to those whose heritage they are.

Socially and politically, it is clearly undesirable to foster a cleavage of interest between agriculture and the rest of the community by isolating the countryside from the effects of the impact of town life. Agriculture and agricultural workers have a more positive part to play in the life of Great Britain, and they can only play it if they are brought more closely into touch with what is the major part of British life. Equally it is true that closer contact with the countryside is desirable to give balance and health to the industrial population, and an agricultural policy which accepts as inevitable an antagonism between town and country would be nothing less than a national disaster.

The happy marriage thus foreshadowed between agriculture and nutrition could have no more valuable consequence than that the changes in agriculture would involve a smaller number of workers in a prosperous agriculture providing adequate standards for the worker and making isolation as unnecessary as it is undesirable; such changes, if combined with careful control of constructional developments, would leave unimpaired the major amenities of the countryside, and also create new forms of amenity, all of which would be accessible to a larger proportion of the population than can enjoy the countryside to-day. Such a policy would firmly establish a harmony of interest between town and country which would make for mutual understanding, goodwill and the dynamic adaptation which Prof. Dennison is assuredly right in holding should mark a positive policy in the interest of the nation as a whole.

Whatever the difference between majority and minority reports in regard to outlook and policy, and as to the objective which should guide a national policy—and clearly these are great—there is agreement as to the imperative necessity for more effective planning of land utilization in England and Wales. Both apply pressure at the point at which the Government is most dilatory, and there will be grave dissatisfaction if there is now any further prolonged delay in providing the machinery and the legislation in readiness for the work to be done when the War is won. A large part of the means of establishing a policy which will command the full support of forward-looking minds in all parties is now in the hands of the Government, and though it is clear that there are fields in which policy has yet to be thought out and investigations completed, public opinion will assuredly look for the action which will equip the country to seize the opportunities which will presently be ours.

THE TRIUMPH OF TIME

The Conquest of Time
By H. G. Wells. (The Thinker's Library, No. 92.) Pp. x+86. (London: Watts and Co., Ltd., 1942.) 2*s*. net.

THIS little book has been written by Mr. Wells to supersede "First and Last Things", which was his attempt in 1908 "to get my ideas about the world and myself into some sort of order". The new volume is stated on the cover to be the author's presentation of "the final fruits of his philosophic thought", and he himself presents it as "a fairly lucid and consistent summary of modern ideas concerning the fundamentals and ultimates of existence". The change of title is at least appropriate, for one who has conquered time becomes as God, with whom there is no last or first, and the brevity of the book is as commendable as it is rare in a treatment of so large a theme.

Mr. Wells's philosophy is as follows. The individual human life is a synthesis of isolated experiences, often mistakenly regarded as continuous. This illusion of temporal continuity creates a dread of its cessation, death, and of pain, and gives rise to an idea of persistence after death which imposes the tyranny of the dead past on the living present. The individual is actually an element in a larger structure, the species, with which it interacts. The character of the species largely determines (through both physical inheritance and mental adaptation) the character of the individual, whose variations from the norm in turn react on and modify the character of the species. The individual life is thus not "a tale told by an idiot"; it is a factor in the progress towards "the awakening of consciousness in the universe". As the universe through the species advances to this goal, the successive generations of individuals gradually become freed from the tyranny of time. They cease to fear death, they acquire more knowledge of the forgotten past and more insight into the future, thus acquiring "an ever-expanding Now". The religion of the new man "demands the subordination of the self, of the aggressive personality, to the common creative task, which is the conquest and animation of the universe by life". The full course of the individual human life will be "from action to an ultimate serene and impersonal contemplation. The body and the personality will die at length like an old garment laid aside".

All this drama of evolution, however, is simply an appearance to our conscious life of what is actually a rigid, determined system in four-dimensional space-time. The latter is the reality; "it is simply from the subjective and illusory point of view that there seems to be free movement"—that is, movement along the time axis. "Our consciousness is a series of delusively unified conditioned reflexes"—an "illusion of a unified personality" which "joins up a series of traces which constitute our conscious life". The passage of time is an illusion; all that is actual in personal life is a discrete set of static points in the rigid four-dimensional system, and somewhere in that frame, at places having higher values of the *t*-coordinate than ours, a very much larger number of points—"the universe"—possesses consciousness (which presumably means that it also has illusions, though Mr. Wells does not state specifically what the life of the universe is). This is the conquest of time.

As a summary of a lifetime's study of the fundamentals and ultimates of existence, the book is surprising in two respects. In the first place, it is written more carelessly than one would have thought fitting for the occasion. True, we sometimes meet the perfect phrase—for example, the reference to "a God-shaped void" in the mind of the infant—but more often passages occur which seem meaningless, such as "this present period of world warfare, in which . . . people die far more significantly than they have ever died before", or "Natural Philosophy . . . went along the line of science, in the expectation that a great free correlation of individual effort would ensue without further effort as the collective truth". Secondly, there is little of the "serene and impersonal contemplation" which is to mark the maturity of the new man and which, we are told, one may "share to a very considerable extent even now". The book is as full of vigour and combativeness as anything that Mr. Wells has written; it looks for strength in vitriolic protestation rather than in quietness and in confidence. It impresses one, in fact, as the product more of temporary excitement than of settled conviction.

It is, however, the substance of the book, and not its form, that calls for chief attention, and it may be said at once that it is unconvincing. To explain why, it is necessary to consider briefly what we mean by time, and how we have come to mean it.

It is not generally realized by modern scientific thinkers what little prominence time had in pre-Galilean philosophies. It was taken for granted as being practically identical with consciousness itself, thus calling for no special thought on its own account. The great achievement of Galileo was to create conceptions in terms of which motion could be treated mathematically, and to this end he represented time as *a space-like dimension which could be measured*—divided up into equal parts as a length is. But this dimension, or spacified extension, of time was so conceived for the one purpose of making motion amenable to mathematical treatment. The world describable in terms of it was specifically limited by Galileo to the world of mechanical phenomena. All else—even physical experiences like heat, sounds, smells, colours and the rest—he excluded from this world and located in the perceiving being.

It is difficult to over-estimate the value of this colossal achievement, for it has made possible the whole of modern physical science. It is difficult also to over-estimate the illusions it has created, for, having seen the value of the concept of 'spacified' time in mechanics, subsequent thinkers, less perspicacious than Galileo, have taken it to be a universal receptacle for the whole of human experience, and therefore as representing in a more precise form everything that human consciousness has ever meant by time. Consequently, the whole of experience has been distorted to fit a concept to which most of it is non-conformable. Our experiences have been ranged out in the mathematical continuum, and hopes and fears and passions (which are obviously non-spatial) have been placed cheek by jowl with the spatial positions of mass particles as occurring at such and such instants of spacified time, and the incongruous "history" thus built up has been regarded as something objectively "true" and infinitely more "realistic" than the direct experiences which have been so regimented.

How different our modern conception of time is from that of pre-Galilean thinkers may be illustrated in several ways, of which perhaps the simplest is to ask what we mean by the "reversal" of time. We take this now to mean simply a reversal of the order of events in the time sequence, made visible by running a cinema film backwards, because we have lost the habit of thinking of time except as a space-like dimension. To a pre-Galilean, however, the phrase would have seemed rather silly, but it would have suggested a state of mind in which one knew the future but not the past, and as fast as the future became realized it would be forgotten except in so far as we might calculate it as we now calculate future eclipses. The reversal of time would have been a passage from actuality into impotentiality, instead of that from potentiality into actuality of which we are, in fact, conscious. The loss of ready awareness of this aspect of time, and the imposition of another, admirably suited for its purpose, on the whole of experience, for most of which it is not at all suited, is the true tyranny, and the first step towards any conquest of time must be the relief of our thought from this incubus.

Towards this end Mr. Wells contributes nothing. He accepts unquestioned the Galilean conception, in its Einstein-Minkowski rather than its Newtonian development, and is blind to all that it ignores. He tries to mould experience to fit it, and thinks that he has thereby released experience from it. His "conquest" of time is, in fact, a complete and whole-hearted surrender. He maps out the history of the individual and the species; shows where our various emotions and aspirations are located in the time sequence of the individual; is convinced that when he has so distributed all the experiences which come within range of his knowledge the individual ceases to be; and sums up our personalities as merely "serviceable synthetic illusions of continuity".

Mr. Wells's view of the space-time continuum of relativity is fundamentally erroneous. That continuum is a conception, a development of the original Galilean terms more flexible than the Newtonian development, and so better fitted for the purposes of mechanical physics. It is not, as Mr. Wells imagines, something independently existing to which experience must be adapted, but precisely the reverse. We do not explore the universe and count its dimensions; we try to rationalize our experience of movements, and choose as a means of doing so the concept of a continuum of 1,2,3 . . . . or n dimensions, whichever makes our task simplest. In science experience is sacred. We may describe it as we like in order to establish rational relations between one experience and another, but what we cannot do is to deny it; hence whatever we do with motion cannot legitimately contain a denial of it. Now let us hear Mr. Wells: "From the standpoint of the space-time continuum there is no movement; the whole system is rigid. It is simply from the subjective and illusory point of view that there seems to be free movement." He takes the Frankenstein monster and puts the experience for which it was created under its control.

This inversion of the order of scientific reasoning, by which experience is subjected to the creations of reason instead of being the origin and end of their creation, is so vital to the whole subject that another example will not be out of place. "In our universe", writes Mr. Wells, "the extreme limit of motion is 299,796 kilometres a second. Nothing has even been known to go faster than that. You can imagine yourself doing so, you can imagine yourself on a rocket going at 299,796 kilometres a second, and you can imagine yourself standing up and leaping forward so as to go faster than that alleged maximum. But in reality you cannot do that. You are imagining the impossible."

This is quite wrong. Whether the rocket is moving with any speed at all or is at rest, you can leap forward just the same; it is, in fact, the first principle of relativity that what happens in a system is independent of the uniform motion of that system as a whole. The finite maximum of material velocities is a characteristic not of motion but of *the terms in which we choose to measure motion*. What is true is that, when we leap forward from the rocket, an observer to whom the rocket is moving at Mr. Wells's speed and who adopts our customary method of measuring velocities, will find our speed represented by the same number as that of the rocket. But we can with equal justification choose a different scale of velocity units such that any velocity up to infinity is possible. Bridgman has described a simple process which will serve our purpose. Imagine a framework carrying a string along which a transverse vibration may be sent at a definite speed relatively to the framework. Call this unit speed. Now let the framework of an exactly similar system travel side by side with this vibration. The vibration of *its* string will then move forward (relatively to the first framework, which is the standard of rest throughout) at two of our units of speed. By continuing the process we can build up a scale of velocities extending upwards to infinity.

Now let us measure some naturally occurring speed—that of an α-particle, say—by such a scale. Then there is no limit to the speed which may be reached. We may imagine a particle, when it is near the speed of light, emitting an electron in the same direction which travels twice as fast by this scale as the particle itself. By our ordinary system of measurement the electron would be reckoned as moving only slightly faster than the α-particle. That is because the limitation is inherent in the method of measurement; it is not something imposed on the behaviour of the moving body.

We may take a third system of measurement. A moving body can exhibit a Doppler effect, and we can measure its speed by the displacement of a spectrum line. Choose a scale of velocities such that velocity is proportional to the change of wave-length, $d\lambda$; for any speed small compared with that of light this will be very close to our present scale. But now with this scale a speed of recession may be infinite, but a speed of approach cannot be greater than a certain finite value, simply because a wave-length can be *increased* without limit, but cannot be *decreased* below zero. The same moving body, measured from in front, moves with the finite speed of light, and, measured from behind, moves infinitely fast. The fact is that we can impose a finite limit on speeds, or let them become infinite, by suitably choosing our arbitrary procedure for measuring them. This is literally true, because "finite" and "infinite" pertain to *measures*, and not to what is measured. They are characteristics of *numbers*; they have nothing to do with experiences—or with Nature, if one prefers that term.

The deeper insight into the character of scientific reasoning which relativity has made possible is not to be fully appreciated in a generation, and no reasonable person would expect Mr. Wells, whose synoptic view takes the whole field of human endeavour as its field, to be familiar with all that many specialists still find strange and paradoxical. But when he takes this very point of the maximum attainable velocity as the text for a sermon on the "great irritation of commonplace people" faced with the necessity of shedding cherished ideas; and, further, builds on his own misconceptions a system of philosophy which he presents with such blind dogmatism that he can declare that one who sees its worth "is bound to regard a bishop or a contemporary statesman as somewhat of a barbarian and morally and mentally his inferior. . . . It is difficult to talk to them as equals"—even those who most admire Mr. Wells's great gifts and are most conscious of the sincerity and disinterestedness of his efforts towards a better and happier state of existence, must feel the necessity of pointing out that his magnificent castle is nothing but a mirage, and that he has little chance of seeing anything more substantial until he is prepared to grant some measure of intelligence to those who announce a different prospect, even though to him it may seem only a sandy waste.

So much for the error which lies at the root of Mr. Wells's philosophy. It remains to indicate the illusory character of the most prominent feature of the philosophy itself. He is clearly justified in regarding the individual, the self, as a conception ("illusion" is not the right word) of continuity binding together a discontinuous set of memories. I can remember some incidents in my life, between which gaps exist in the time-scale, and to rationalize my experience I therefore form a conception of a continuously existing individual, my "self", of whose career I have forgotten some portions. In the same way, if I observe a sunspot on Monday, miss the cloudy Tuesday, see it nearer the centre of the sun's disk on Wednesday and later near one limb of the sun, lose it for a fortnight or so, and then pick it up near the opposite limb, I form a conception of a continuously existing spot which has rotated uninterruptedly with the sun. There comes a time, however, when I no longer see it where the postulated continuity of existence would lead me to expect, and I say that it has ceased to be —or has "died" if I wish to be poetic. Now it may be that my continuous self will similarly cease to be—I do not doubt it—but I see no reason to suppose that therefore I, who conceived it, will thereupon cease to be conscious, any more than I ceased to be conscious when the sunspot ceased to be. Anyone who thinks I will must give some reason for his belief; there is none in the mere ending of what Mr. Wells goes so far as to call an "illusion".

The fallacy in Mr. Wells's argument is that he confuses the subjective, conscious individual, which is never in the time dimension or time stream or whatever it may be called, with the postulated object of consciousness—the continuously existing self which is conceived so that it does lie along the time axis. The one fundamental and inescapable characteristic of the conscious individual is that it is always and only at the present; I cannot be conscious at any time but *now*, and this is not an accident, it is obviously of the very essence of consciousness. The conquest of time consists simply in realizing that we already know that. All the interactions of the postulated individual and the postulated species which Mr. Wells describes so succinctly are actual and important, but they do not touch the question of the destiny of the conscious individual; they refer to a few among the many things of which he is conscious.

Despite the length of Mr. Wells's extension along the t-axis, he is still mentally as young as ever. We may therefore hope that in after-years, when these wild ecstasies shall be matured into a sober pleasure, and he has reached the serenity of contemplation into which the individual life shall widen out, he will give us another version of the final fruits of his philosophic thought. It is distressing to think that a life of such great achievement and penetrating vision should culminate in such an anticlimax.

HERBERT DINGLE.

INTROSPECTIVE PSYCHOLOGY

Body and Self, One and Inseparable

Also Cosmic Rays and Light and other Writings. By Percy A. Campbell. Pp. vii+156. (San Francisco: George Fields, 1942.) 2.50 dollars.

THIS book consists of an essay in introspective psychology, and miscellaneous papers written between 1933 and 1942, which are chiefly concerned with the primary cosmic rays.

The value of any work in introspective psychology is difficult to assess as there is no objective standard against which it can be measured. It can only be referred to the self-observation of the reader, who, if he is to avoid dogmatism, must tacitly prefix the phrase 'so far as my experience of myself is concerned' to any judgment which he may make about it. The only approach to an objective standard would lie in the work of great artists, poets and philosophers, whose peculiar genius it is to express emotional and intellectual experience which is common to all, and in which we realize ourselves to be at one. The language of this experience being artistic and conceptual symbolism (as found in great works of art and systems of philosophy), introspective psychology would appear to be an inhabitant of the mind's no-man's-land, belonging neither to science, art, nor philosophy. In my own view, however (and all statements in this review will perforce be based upon that), the value of such an essay as this lies in the fact that it does strike a note in the mind of the reader which sets him thinking; and that it does suggest a new pattern for his thought useful to him in whatever branch of life he may be working.

Mr. Campbell was a pupil of William James for a short time, and the essay takes the form of a commentary on James's thought and psychological observation. The main thesis is that the centre of consciousness is not in the brain, but in the sensorium. The brain is merely the 'central telephone exchange'. Consciousness proceeds from the functioning together of the various elements in the body. The James-Lange theory, referred to frequently in the essay, is the classic example of this position. It follows that 'conscious is as conscious does', and that psychology has no need of a separate self, a *deus ex machina* aloof and exalted. Individuality depends upon the manner of integration of the bodily functions. To take an analogy from art, the self is like an æsthetic whole, which is dependent for its own particular wholeness upon the relationship of the elements used in its creation: though these elements—for example, colour, form, and canvas—may not vary, they may produce an infinite number of 'wholes'.

Another implication of Mr. Campbell's position is "consciousness is consciousness only to itself". Belief in the soul is a "song of the sensorium"; a false sense of selfhood and separateness arising from the play of consciousness upon itself. Many great thinkers have been "soul-mongers", and Mr. Campbell instances James himself as an outstanding example.

Mr. Campbell's thesis strikes a very familiar note in my sensorium (or, rather, in the sensorium that is me). The intellectualist *deus ex machina* is well and truly consigned to limbo, together with all the notions of separateness which go with it, and all the volumes of metaphysical sticking-plaster which have gone to rectify a state of affairs which never existed. Sentimental 'uplift' has been well and truly pinned down as a "song of the sensorium", and one finds oneself collecting other examples of that handy form of entertainment. But does Mr. Campbell go far enough ? After reading his book I find Shelley's question rising unbidden in my mind :

> "Whence are we, and why are we ? Of what scene
> The actors or spectators ?"

To pursue the analogy of the self and the artist's canvas, what of the *idea*, the motive force which both preceded the grouping of colours and forms and which finds expression as the genius, the *raison d'être*, of the picture ? It did not just happen. It was generated in someone's mind. Does Mr. Campbell, therefore, pursue his analysis far enough to be justified in his conclusions ? If the affirmation of the soul is a 'song of the sensorium', the negation of the soul smacks dangerously of being another. Although it is agreed that there is no separate self, the existence of a principle of integration, different in different individuals, is actually implied by this essay, while involving no idea of separateness. Some such notion as this seems to have been at the back of James's mind in the passage quoted as an example of his "soul-mongering".

"The perfect object of belief would be a God or 'Soul of the World' . . . so definitely conceived as to show us why our phenomenal experiences should be sent to us by Him in just the very way in which they come. . . ." ("Principles of Psychology", vol. 2, p. 317, quoted on p. 116).

Lastly, it is worthy of mention that the greatest 'soul-mongers' have been fully convinced of their own impermanence, and have been certain that their reality lay in their being an effluence, an expression, a creation. B. M. B.

DISCUSSIONS ON CITIZENSHIP

Handbooks for Discussion Groups

No. 1 : How to Lead Discussion Groups. By E. M. Hubback. No. 2 : The Democratic Idea. By Francis Williams. No. 3 : Is Britain a Democracy ? By Frank Hardie. No. 4 : Our Towns. By Elizabeth E. Halton. Pp. 24 each. (Published for the Association for Education in Citizenship.) (Bickley : English Universities Press, Ltd., 1942.) 3*d.* net each.

THE series of Handbooks for Discussion Groups which has been issued by the Association for Education in Citizenship, judging by the four which are here under notice, appears to be admirably designed for the purpose it seeks to serve. There can be no two opinions in a democratic society as to the crucial importance of the organized discussion of the social, economic and political problems which have arisen or are arising out of the War. The pamphlets are based frankly on the idea of democracy and in support of what the enemies of the democracies in this War are attacking under the name of humanitarianism. Moreover, this conception of fundamental human rights as individuals and as citizens is recognized as carrying the corresponding obligation for the community as a whole of securing for its members the fullest development of which they are capable in both these capacities, and at the same time of training them in respect for the equal rights and freedom of others.

The first of these pamphlets, by E. M. Hubback, "How to Lead Discussion Groups", deals with the efficient setting up and running of such groups. It is intended mainly for the use of less experienced leaders and chairmen of small groups anxious to discuss public affairs, but the greater part of the pamphlet is occupied by an excellent bibliography ranging over modern political ideas ; government institutions and social and economic problems in Great Britain ; the British Commonwealth ; foreign countries ; international affairs ; and on clear thinking and psychology. This bibliography, though selective, is well balanced and should render the pamphlet of much wider service than to the novitiate in group discussion.

Mr. Francis Williams's pamphlet (No. 2. "The Democratic Idea") is of an entirely different type. In four brief chapters he sets forth lucidly and suggestively the challenge that is inherent in the democratic idea, its slow emergence from the first stirrings in ancient Greece to the American Declaration of Independence, its meaning and effect on the whole pattern of our lives, the values that spring from this recognition of human dignity, and the practical problems that confront us as we seek to translate the ideals of democracy into a system of living as a community. The task of relating the latest expression of democracy in the four freedoms of President Roosevelt with its historical origins and slow evolution could scarcely have been better done in such brief compass, and Mr. Williams does not fail to lay stress on the duties as well as the privileges of democracy, or to indicate the ways in which we may equip ourselves to discharge such responsibilities.

Elizabeth E. Halton's pamphlet (No. 4. "Our Towns") is equally felicitous. Her method is entirely different. Rapidly but concisely she travels over the whole range of problems involved in rebuilding our towns, from the design of the house to suit the needs of widely varying types of occupation, the problems of roads, of open spaces, of transport, the location of industry, the planning of town and countryside, to questions of cost and maintenance. Her annotations are good, and discussion groups taking up this pamphlet should be enabled to arrive at a sound and well-balanced opinion on the policy and action that will be required.

Mr. Hardie's pamphlet (No. 3. "Is Britain a Democracy ?") is scarcely in the same class as the other three, but none the less should serve its end, though his bibliography is open to criticism as much too limited. It is longer than the others, but it covers its ground thoroughly and is likely to stimulate lively discussion when used intelligently. Of this no less than of the remaining pamphlets, it can be said that they should not disappoint the hopes of the Association for Education in Citizenship that they will play a useful part in ensuring that the inevitable changes in social arrangements and assumptions are faced in an atmosphere of co-operation and goodwill.

LAND UTILIZATION IN ENGLAND AND WALES

THE report which the Committee on Land Utilisation in Rural Areas, under Lord Justice Scott as chairman, has submitted includes the majority report and also a minority report by Prof. S. R. Dennison, which differs in outlook and its observations on policy rather than in the detail of the actual recommendations, particularly in regard to machinery and procedure, a note of reservation by Prof. Dennison and Mrs. H. Hichens and an additional memorandum on valuation and rating by the chairman, vice-chairman, Mr. H. S. Cooper, Mr. A. E. Monks and Mr. P. Robinson. The Committee was appointed by Lord Reith in October 1941 to consider the conditions which should govern building and other constructional development in country areas of Great Britain consistently with the maintenance of agriculture, and in particular the factors affecting the location of industry, having regard to economic operation, part-time and seasonal employment, the well-being of rural communities and the preservation of rural amenities. The terms of reference did not include Scotland.

The majority report is in three parts. The first reviews the present position, successive chapters dealing with the land and population, the countryside, the impact of town on country, the effects of urban growth on the countryside, the War and probable post-war trends and planning powers. The admirable chapter on the countryside describes the pattern of the countryside and its evolution, including the influence of agriculture and types of farming and factors determining farming systems, the origins of the landscape pattern and the changes during the last few decades, as well as the drift from the land and its causes. The Committee points out that the beauty and pattern of the countryside are the direct result of the cultivation of the soil, and there is no antagonism between use and beauty. The physical impact of town on country is then analysed, as well as the consequences which have flowed from the greater appearance of the townsman in the country, whether as a rambler, a motorist or a week-end visitor. A study of the effects of urban growth on the countryside leads to the conclusion that, on balance, more harm than good has been done to the countryside in England and Wales by constructional development before the War, while the broad conclusions reached as a result of the review of the developments of the pre-war years and the changes brought about by the War are that the former trends of constructional development, with some slight modifications tending to a greater diffusion into country areas, will, unless checked and diverted, reassert themselves after the War. A post-war building boom, possibly even more intensive than that which took place in the 1920's, if left to take care of itself, will lead to the same and probably worse evils than those which characterized the inter-war period. The evils to the social well-being of town inhabitants as a result of ill-considered or uncontrolled urban spread are now well known, and the evils from the point of view of the countryside were no less apparent in the years leading up to the present War. The future of the countryside will be profoundly affected by the choice between haphazard and planned constructional development.

This argument for the immediate establishment of the necessary machinery for planning and control is reinforced by a survey of present planning powers, both of the Town and Country Planning Act, 1932, under which the unwillingness of many local authorities to collaborate with their neighbours has been lamentably apparent, and of the Restriction of Ribbon Development Act, 1935, the weaknesses of both Acts being concisely indicated. Both failed for the same reason—the claims for compensation against the authority administering the Act. Assuming therefore that the policy of the Government includes the establishment of a Central Planning Authority, the Committee in the third part of the report outlines the machinery and procedure required for planning and development. The Government machinery for the formulation and execution of national planning is conceived as consisting of a standing committee of the Ministers concerned under the chairmanship of a non-departmental Minister of Cabinet rank, Government departments concerned with development, a Central Planning Commission and such *ad hoc* bodies as may be required to carry out functions not already covered by existing Ministers or other authorities or bodies.

The Central Planning Commission should consist of a full-time independent paid chairman, with ministerial status, and a number of part-time or full-time commissioners chosen on account of their special qualifications and knowledge as individuals of proved ability in their own spheres. The staff of the Commission should consist of Civil Service personnel, chosen with an internal knowledge of the departments with which the Commission will be in contact, and other persons, including some specialists, chosen for their knowledge of particular subjects and the prosecution of research. Outside London, the Commission should be represented by local officers to settle so far as possible all matters of local importance.

The duties of the Commission should include unified research and inquiry; the collection and correlation of information and the direction of research in connexion therewith; the formulation of national planning principles in accordance with directions received from the Minister, and the translation of national policy into concrete terms of national planning; the formulation and communication of general principles for the guidance of local planning authorities and the initiation, either direct or through the local officers, of schemes of national importance; and the approval or disapproval of plans submitted by local planning authorities and decisions thereon in accordance with Government policy. While much of the work of the Commission will be advisory, there should be a statutory obligation on all departmental Ministries to afford all requisite information to the Commission, and to consult with it and to consider its advice. Exceptionally, bodies with executive powers, for example, a National Parks Authority, may be set up where the policy of the Minister of National Planning requires executive action.

In regard to local planning, the report recommends that the local authorities continue to exercise their functions as planning authorities, but no longer without guidance, and it should not be possible for local authorities to refuse to co-operate in planning schemes. Local planning must be compulsory and not permissive. Normally, the primary local planning unit should be the county or a county borough and its surrounding area, or a comparable combination of local government units. Qualified personnel must be employed, and consultation between neighbouring planning authorities be compulsory. Local planning authorities should be freed from the restrictions in zoning agricultural land due to liability for compensation, and where they are carrying out their assigned part in a national plan, the expense should not fall on their own local financial resources.

In regard to procedure, the Committee considers that direct national action on broad lines will be required by the Central Planning Authority without waiting for the formulation and submission of planning schemes by local planning authorities. The work of determining the main types of land along the lines used by the Land Utilization Survey is part of the research which should be organized by or on behalf of the Central Planning Authority. The recommended procedure for controlling land use in country areas involves the national delineation of certain land areas; the local zoning of land similar to that adopted in present town and country planning schemes; and the consideration of individual cases in certain zones where such a course appears desirable.

In planning rural land, the majority report recommends that particular importance should be attached to agricultural considerations, and that land included in one of the categories of good land should not be alienated from its present use unless it can be clearly shown that it is in the national interest that the change should be made. Again, the majority report recommends that the power of compulsory acquisition of land by the State be exercised where required in the interests of national planning or for achieving that high degree of permanent efficiency in agriculture which vitally affects the essence of the problem. They recommend that the new 2½ in. to the mile maps be made available for all planning purposes, and stress the importance of adequate status and training of planners and architects. Great importance is attached to a very high standard of professional qualifications being required and maintained.

In the fourth part of the report, there is outlined a five-year plan for England and Wales, starting from the position as it will be after the War and not as it is at this moment, though between then and now the extremely important work of recording war-ime changes and of collecting and tabulating statistically and cartographically the developments now taking place must be completed. Research work carried out by the Planning Division of the Ministry of Works and Planning, the Farm Survey of the Ministry of Agriculture, and the Nuffield College Social Reconstruction Survey are regarded as essential parts of the war effort. A proper co-ordination of the research underlying national planning is an ssential function of the Central Planning Authority. While some of the essential research cannot be carried ut until the War ends, the Committee recommends that a plan be drawn up, consistent with the general olicy for continuous national planning, of work to be completed within five years.

Within the first year, the system of land classification for planning purposes should be agreed, and the standard procedure for co-operation between the appropriate town-planning officers and officers representing agricultural and rural interests laid down, the panels of architects and planners set up, the comprehensive investigation of electricity, gas and water supplies and the demarcation of national parks and natural reserves completed, and the National Parks Authority established. The Government should lay down a definite agricultural and food policy for at least five years, having regard to the increasing knowledge of nutrition and the national health. Within the five years there should be completed first town- and country-planning schemes to cover the whole of England and Wales, providing a full indication of the areas where industrial zones are or are not to be established, and satellite towns or new settlements located; secondly, a definite number of houses for rural workers; a full survey of all villages and hamlets to determine the existing facilities for village social centres (including playing-fields), and the drawing up of a plan for the provision where suitable of centres of the village college type, and the opening in all counties of a long-term building programme; programmes for electricity, water and gas, based on the survey made in the first year; the national park scheme, with hostels, etc., in working order; the determination and sign-posting of all footpaths and bridle-paths; rules, if any, for the control of access to the countryside, the use of commons and highways and other rights of way; the elimination of unsightly advertisements, petrol stations, etc.; and the registration of title. With all this, an educational campaign to promote better understanding between town and country should be carried on continuously.

This outline of the recommended five-year plan indicates how comprehensive are the recommendations of the majority report detailed in Part II and summarized in Part V. Some of these have already been outlined in describing the five-year plan. Others relate to forestry and arboriculture, where an extension of afforestation on poor land together with the establishment of foresters' part-time holdings and national forest parks are recommended, as well as enforcement by the Forestry Commission of the proper management of all woodland in the country. In regard to village institutions, establishment of a permanent advisory committee on village life and institutions is recommended, as well as the provision of adequate playing-fields for every village. The importance attached to housing, to the provision of electricity at no higher price to the consumer than in the towns, the extension of gas supplies to rural areas, to a review of the whole question of water supply, all undertakings for which should be brought under national planning control, has already been indicated, while other major recommendations cover industry in country areas and housing and planning in such areas, as well as such matters as aerodromes, defence works, roads and railways, advertisements and cemeteries.

In regard to the farmer, it is recommended that extractive industries should be subject to effective planning control, and that in principle no person or body should be allowed to work land for the extraction of minerals and leave it in a derelict condition. Legislation should be passed imposing an obligation on all those who derive benefit from the working of land for minerals to restore that land for agriculture or afforestation or other purposes within a short specified time after the land has been worked out. The dispersal and future use of war factories established in the countryside should be determined by the Central Planning Authority in conjunction with the other departments concerned. Linked industries should remain in existing urban concentrations or trading estates, and where light industries are brought into rural areas, they should be located in existing or new small towns. Production and storage units of public utility undertakings located in villages or in the open countryside should be subject to street planning control as regards siting and appearance. Rural trades and crafts should continue to be sited in small towns or villages and should be encouraged. No modern industry has been suggested which would provide seasonal or part-time employment for agricultural workers and their families, and appropriate bodies should be asked to make a special study of this problem. Before new towns are established in country areas, vacant or derelict industrial sites in existing towns should be fully utilized. New satellite towns, housing estates, garden cities and suburbs should be sited wherever practicable away from the better farm land, and due attention paid to agricultural considerations in their siting. Sporadic buildings in villages and rural areas should be controlled, and new villages and extensions of villages should be planned and should be so far as possible of a compact and closely knit character. All new villages and country towns should be situated away from main traffic roads though within easy access of them, and all existing villages and country towns which have main traffic roads running through them should be by-passed so far as possible. New buildings in country areas should use to the full all the possibilities which new materials and new building techniques have made available, though the buildings should be designed so as to harmonize with their surroundings.

THEORY OF X-RAY DIFFRACTION

By PROF. P. P. EWALD
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THE numerous books on the diffraction of X-rays by crystals all treat the subject with the view of introducing the reader to the methods for determining crystal structures. It is true that some presentation of the theory of optical interference cannot be omitted and that the various books go into this theory to varying degrees. But it is only v. Laue's recent book* which makes the optical theory of X-ray interference in crystals its main aim. In it, the usual methods of crystal structure determination are curtailed or omitted, since they involve more geometrical than optical discussion, once the reduced intensities are taken as known. Omitted as well is the description of experimental methods, as the emphasis of the book is on theory.

What variety and scope the subject presents will become apparent on comparing it with the corresponding theory of the diffraction of light by a plane optical grating. This theory consists of two parts: the diffraction by a single element of the grating (slit, wire or groove) and the action produced by the repetition of such elements. The first part is not important for most aspects of the effect of a plane grating, other than the distribution of intensities over the spectra of different orders. Its counterpart in X-ray diffraction is the theory of the atomic factor, and this brings the subject at once into the domain of wave-mechanical atomic theory.

The second part of the theory, the grating effect proper, is more involved for X-rays by the fact that they encounter in a crystal a three-dimensional grating. This fact leads to geometrical propositions concerning the main directions of diffraction which equal in beauty the geometrical constructions of the Fresnel-Hamiltonian crystal optics. Furthermore, the three-dimensionality of the crystal shape is carried over to the array of secondary diffraction maxima which surround each main maximum. The resulting complicated intensity distribution in space, modified by the 'crystal shape factor', is the three-dimensional generalization of the well-known one-dimensional diffraction function which determines the resolving power of a plane grating of finite width.

The most profound influence of the three-dimensionality is, however, to be found in the strong interaction of each element with all its neighbours; this makes the theory of diffraction a part of the major problem of the propagation of an optical field through the crystal, that is, part of the problem of refraction and dispersion by the crystal. The resulting 'dynamical theory' of X-ray diffraction is fully treated in Laue's book.

While these points still bear a correspondence to the problems encountered for the plane grating, there are three others which have no counterpart. The first of these is due to the thermal motion of the diffracting centres, which not only produces an unavoidable irregularity of the lattice but also endows each centre with a velocity leading to a Doppler effect of the scattered radiation. The second new point is the production of scattered radiation of incoherent character and of Compton-modified frequency. The last is connected with the possibility of generating, for example by electronic bombardment of the crystal, monochromatic radiation at the interior of the crystal; this radiation has been shown by Kossel to emerge preferentially in certain directions.

The aspects of the theory as enumerated determine the scheme of Laue's book. The author starts with the theory of atomic scattering along wave-mechanical lines, but in rather a novel manner. He first points out that the general theory of integration of Maxwell's equations permits the introduction of various forms of scalar and vector potentials. Now for the perturbation problem of finding the scattered radiation without blurring the distinction between the perturbing incident potential and the normal constitutiona potential of the atom, only one of these forms i suitable, namely that in which the fields derive from the vector potential cannot cancel those derive from the scalar potential. This is true for the aton as well as for the entire crystal, and the correct introduction of the potential is essential for the unity o method in treating atoms and crystals. The fu development of the method will be found in the paragraphs introducing the dynamical theory, where th wave-mechanical concepts are further related t classical Maxwellian theory. The existence of th Schroedinger current can be interpreted classicall as due to a changing polarization, and the polarizatio together with the electric field vector E can be con pounded to a dielectric displacement D. This is a in Lorentz's theory of electrons, except for the diffe ence that D is here a vector locally determined by th ψ-function for each electron, and not an averag value over a distribution of polarization unknown i detail. The distinction between E and D leads to th definition of a dielectric constant which for a cryst is a periodic function in space. The theory of diffra tion and of scattering is thus reduced to the proble of integrating the Maxwellian equations for tl propagation of waves in a medium of varying dielectr constant. These variations are determined, accordi to wave-mechanics, by the ground state of the syste as long as absorption is negligible, and by high states as well near absorption edges.

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* Röntgenstrahlinterferenzen. Von Prof. M. v. Laue. Pp. viii+358. (Leipzig: Akademische Verlagsgesellschaft Becker und Erler Kom. Ges., 1941.)

The reduction of the problem of X-ray diffraction to wave-mechanics has been developed in papers by Laue and his co-workers Kohler, Moliere, Lamla, but it is given a more connected discussion in this book. Its main advantage is the uniformity of method in treating the scattering by atoms, molecules and crystals, and for the latter the foundation of the dynamical theory on the Fourier series for the electron density in the crystal.

Among the problems that have to be dealt with by the dynamical theory are the intensity of reflexion by a perfect crystal, the multiple reflexion resulting in a weakening (*Aufhellung*) or strengthening (*Umweganregung*) of the main reflexion, and the "lattice source method" of diffraction of Kossel. The latter has been reduced in a most elegant way by Laue to the established formalism of the dynamical theory by using an optical reciprocity theorem which relates the intensity received outside the crystal from a source inside it to the intensity created by an external source at the point of emission within the crystal.

Apart from the dynamical theory, the optical side of the theory of the temperature factor has been treated with great care and clarity by v. Laue. It is true that this theory remains on the level of the 'kinematical' theory of diffraction which includes only such effects as result from composing scattered wavelets derived from a single primary (incident) wave of given propagation. Instead, the treatment to be aimed at should be to study the propagation of an optical field, consisting of an indefinite number of waves of adaptable velocities, through the temperature-disturbed crystal, in the same way as it is done for the undisturbed crystal in the dynamical theory.

This combined thermal-dynamical theory has so far not been attempted. Laue's treatment is, however, superior to most previous presentations in employing a uniform method for discussing the temperature effect on the scattering by molecules and by crystals. In both systems the thermal displacements can be regarded as due to superimposed normal oscillations about the equilibrium position, and the independent co-ordinates of the system are its normal co-ordinates which perform simple harmonic oscillations of frequencies, say, ν_j. As a result of these, the scattered radiation can be expressed as a sum of components of Doppler-modified frequencies $\omega \pm p\nu_j$, where ω is the X-ray frequency, and p any integer. The intensities of the components are given by Bessel functions, the arguments of which are the 'roughnesses' produced in the reflecting plane by each type of lattice vibration. The main difficulty of the calculation lies in the fact that since the 'roughness' is of the order of the X-ray wave-length, the change of phase produced by the superposition of lattice vibrations is not simply the sum of the phase differences due to each vibration. The result of Laue's careful discussion is that wavelets of unmodified frequency ($p = 0$) are collected in principal and secondary maxima of the same directions as for a lattice without thermal motion; the atomic factors f_n have to be replaced by f_nD_n, where D_n is a Debye factor containing in its argument the mean square displacement of the nth kind of atom taken along the normal to the reflecting plane. All the background scattering is due to radiation of Doppler-modified frequencies $\omega \pm p\nu_j$ with $p \neq 0$, but the change of frequency is too small to be readily detected by experiment. In stressing the Doppler effect, Laue's theory of the thermal factor differs from the recent treatment on wave-mechanical lines given by Born and Miss Sarginson and others, but it seems unlikely that the results would be greatly affected.

As a second step, of purely dynamical, not optical, theory, the mean square displacements of the atoms, resolved along the normal to the reflecting planes, have to be calculated as functions of the temperature. Laue's book, stressing the optical part, does no more than outline this problem.

In the last third of the book, which deals with the dynamical theory, many interesting details will be found apart from the general approach which has already been described above. The theory of Renninger's 'multiple reflection' and of Kossel's 'crystal source method' are worked out; with respect to the former it seems a pity that no attention has been given to the experimental and theoretical work of Weigle and co-workers. A careful discussion is given of the transition from the dynamical to the kinematical theory in the case of small crystals. Another item is the dynamical theory for frequencies near to an absorption edge, following a paper by G. Moliere.

Anyone familiar with the subject will appreciate the sound physical and mathematical basis of v. Laue's book, and the many original and critical ideas incorporated in it. The reading is not difficult in spite of the fairly involved mathematics, and the limitation of the book to points of major optical interest excludes detail which may be necessary for the discussion of experimental data, but which would fatigue the general reader. It is to be hoped that the author may find it possible to complete a similar account of the theory of electron diffraction, a closely related subject on which he has been engaged for the last ten years simultaneously with the subject presented in this volume.

KEY METALS AND THE LOCATION OF INDUSTRY*

By PROF. C. B. FAWCETT
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FROM the beginnings of man's knowledge of metals up to about two hundred years ago, the number of known metals could be counted on his fingers. There were the 'noble', but not particularly useful, gold and silver, and such 'base' metals as copper, iron and lead, which made up for their baseness by being useful. Mercury also has long been known. Bronze and brass were known; though it is doubtful whether their composition and their relations to copper, tin, and zinc and antimony were understood before the eighteenth and nineteenth centuries. The number now known is five times as great. But, except for aluminium, the newer metals are chiefly of importance for their part in the formation of many alloys with the older metals. Iron is still by far the most important base of such alloys, and the most important of all the metals.

The effects on human society of so great an addition to available natural resources are both complex and far-reaching. But here I wish to note only some effects of the use of the key metals on the location

* Paper read at the Conference on Mineral Resources and the Atlantic Charter, arranged by the Division for the Social and International Relations of Science of the British Association, on July 24.

of industry, which is an important factor in the economic and social organization of a modern civilized community.

These key metals are used chiefly in forming, with iron, most of the many steels which are now known and used. Up to a century ago, the only important steel was carbon steel, which had been known to some extent for perhaps two thousand years. But though it was known, in the sense that it could be produced by the smelting of some forms of iron with some forms of charcoal, that knowledge was only empirical. Before the middle of the nineteenth century the making of steel on any large scale was still something of a gamble. The process could not be understood—and so controlled—until the sciences of chemistry and metallurgy had made considerable progress. Then came the systematic study of iron and steel. This led to a knowledge of the solvent powers of molten iron; and so to a study of the properties of the solidified solutions—the steels. Such investigation demanded large-scale organized research, and most of it dates only from the present century, particularly during and after the War of 1914–18. Not all the steels are of present importance. But some of them are so much so that they have caused a revolution in tool materials. There are now steels which are respectively harder, tougher, less corrodable, more resistant to softening at high temperature, etc., and so more efficient for particular purposes, than any formerly known. We have now better cutting steels than before, and others better for other purposes.

It is probably true to say that the sudden improvement in one tool material within this century is a change comparable to that from the ages of stone to the ages of bronze and of iron. Its social effects are not likely to be less than those of the first introduction of metals as tool materials.

The more important of these key metals include chromium, and cobalt, manganese, molybdenum and nickel, tungsten and vanadium—a list which is far from being exhaustive.

In relation to the location of industry, and their effects on it, it may be noted that these metals normally occur in quantities which are small in comparison to the ore bodies of the longer-known iron and copper, and they are found chiefly in rocks of Archean types; and so in areas away from the fertile lands of dense agricultural settlement and also away from the great coal deposits, which are not found in rocks older than the carboniferous. So the sources of the key metals are, for the most part, in remote and thinly populated areas. Secondly, the key metals are used in small quantities, very rarely forming as much as 10 per cent of a steel, and usually much less. So that where iron is needed in thousands or millions of tons the key metal is needed only in tens or thousands of tons. Thirdly, in its relation to industry, it is characteristic that the whole of a key metal used becomes part of the final product. The amount wasted in the process of manufacture is negligibly small.

Many of these metals are found in such a form that the metal itself is only a small proportion of the material mined. Hence there is usually a process of 'concentration' at, or very near, the mine. The location of the mine itself, and of this 'concentration', is of course determined by the place of occurrence of the ores. But once the concentrate is obtained, it is transported to existing centres of industry to be refined and then used; and it seems that the place of occurrence of the ores of the key metal has, in most cases, little or no influence on the location of the industry which uses it.

Let us consider, very briefly, some factors influencing the location of manufacturing industry, and their relation to these metals. Such factors may be grouped as primarily economic, or social, or political, though some may come under more than one of these heads.

The economic factors are chiefly those concerned with the needs for transport and power. In respect to the first, the materials to be used can be divided into (*a*) those which are wholly or mainly used up in the processes of manufacture, and (*b*) those which, like the key metals, form part of the finished product. The latter must, in all cases, be transported from their place of origin to the final user of the product; and usually it makes little difference to cost where they are stopped on this journey to undergo the transformation from raw materials to finished goods. There is, however, a difference according to whether the use is widespread or concentrated. In the case of the key metals it is mostly the latter; for the alloys containing them are built into tools most of which are used in industry (or armaments) and not spread widely in small lots. So there is, in general, an attraction of these materials to the regions of heavy industry, the location of which has been previously determined by facts independent of these metals.

The other chief economic factor is the power required in the manufacture; though this, especially when it is in the form of coal, might be classed as a material which is wholly used up in the processes of manufacture. There is thus a great saving in reducing the transport of such power. This was the attraction which, in the palæotechnic period, brought heavy industries to the coalfields; and it is still important, though the more recent electrical transmission of power has lessened the pull of the coalfields.

The chief social factors in the location of an industry are related to the amount and kind of the labour it needs. In this respect the key metals are easily classed. They are almost wholly used in industries, and sections of industries, which are dependent on highly skilled labour; and the products into which they enter go to similar industries. Hence the key metals come almost exclusively to regions of highly developed—and so generally of long standing—metal industries. By aiding the development of, and the demand for, skilled work, they tend to confirm the existing location of those industries. Up to the present, except for some Government armament industries as in Japan, practically all the key metals are used in the two great zones of established manufacturing industries in eastern North America and in Britain and Europe.

The political factors are very different in their effects. Here the dominant factor is that the key metals are essential to the armaments industry and to the making of tools which produce armaments. Hence, in a world of independent sovereign States, no State can feel itself secure or really independent unless it has within its borders a considerable armaments industry. In fact, no State which is not an important industrial power can, to-day, be an important political power. Thus the political influences on the location of industries are particularly obtrusive in relation to those in which the key metals are vital, and in recent years such political forces have been of primary importance.

The economic and social factors which tend towards the location of the industries using the key metals near the centres of older metal-working industries are further strengthened by the recent tendency—very prominent in steel-making—to an increasing use of 'scrap metal' as a raw material, which has long been practised with the more expensive metals. A note in the *Monthly Labour Review* of May, 1935 (p. 1155) states that in the U.S.A. "scrap iron and steel" formed 9·9 per cent of all the materials used in steel-making, and approximately half of that of the finished steel. These proportions may have increased under war conditions. They are likely to remain high, and to be applied to all metals, if we can attain a sanely conservative use of our metal resources. In that case we would regard the world's stock of a metal as a 'revolving stock'—to be used over and over and only replenished by 'new' metal to the extent needed to make good losses due to fair wear and tear and to provide for new uses.

'Scrap' is already a substantial part of the immediate raw material of these industries. But scrap is produced where metal goods are made and used; so that this part of the raw material comes back from the markets. Thus it tends to increase the pull of the market on the location of the industry, and so to strengthen the factors which keep it in the regions of developed industry.

The increase in the number of different materials needed by an industry necessarily lessens the relative importance of each one of them. So the complex industry, by spreading its dependence over a wider range of natural resources, becomes less dependent on the location of any one of them; and as the factors which influence its location thus become more numerous, the possibilities of effective intervention to control that location become greater.

MINERALS, OLD AND NEW, FROM THE SEA*

By Dr. E. F. ARMSTRONG, F.R.S.

HAD I been writing a book on the subject I should have first described the crust of the earth, some 20 miles in thickness, and then gone on to point out how, by the processes of destruction and denudation, this is continually being washed first into the rivers and finally into the sea, much of it going into solution. As the poet tells us, "even the weariest river winds somewhere safe to sea". The quantity of any one constituent of the crust in a thousand parts of sea-water is infinitely small and indeed many are only detectable by the most refined methods of the chemist, but there is so much ocean in the world that in the aggregate it contains many tens of thousands of tons of even the very rarest constituent.

In the past, but for one constituent—common salt—sea-water has never been regarded as a source of raw materials for industry. To-day three other essential substances—potash, bromine and magnesium salts—are being extracted in considerable quantity from the sea by methods which are both novel and interesting. Such methods open up an avenue to the winning of other even scarcer but coveted minerals.

Common salt is an essential for both man and beast, and those countries which lack it go to any end to obtain it. In New Guinea, for example, it was used by traders not so long ago as the best currency for the purchase of native goods. In Britain and in Europe there are large deposits of pure salt resulting from the drying up of inland seas in past geological ages. The Dead Sea in Palestine is an example of such a sea in process of evaporation. At Stassfurt in Germany the sea dried up entirely, so that both the salt and the mixture of potassium and magnesium chlorides, sulphates and bromides remain in the earth, though, strange to say, there is no iodine.

The composition of the ocean varies considerably in different places and at different depths. The salinity expressed as total salts per 1,000 parts of sea-water varies from a minimum in the southern part of the Indian Ocean, 33·01 parts, to a maximum from the middle of the North Atlantic, 37·37 parts.

In hot countries the sea is led into basins and allowed to evaporate in the heat of the sun until first the calcium sulphate and then the salt crystallizes: the salt is impure but suffices. The bittern or residue is of no commercial value though it has been further treated to obtain potash in an Italian colony.

The export of salt from England has for long been a significant part of our overseas trade. Together with the chemical products made from it, for salt is one of the foundations of chemical industry, it has helped to make Liverpool one of the world's greatest ports.

The exploitation of any particular source of a mineral is determined by economic considerations. Bromine affords a good example: so long as the demand for it was relatively small, the Stassfurt monopoly maintained it at a high price. When it was required in very large amounts to make 'ethyl', other cheaper sources had to be found. One of these is the Dead Sea, which is a half-evaporated inland sea situated in a climate where there is more evaporation than precipitation. As the concentration of salts at the bottom of the lake is greater than that at the surface, the solution is pumped from depth, concentrated and processed to obtain potash salts and bromine, thus affording a British Empire source of these minerals. There are similar inland lakes in the United States. The Americans went to the sea itself for their bromine, having devised a simple method of extracting the traces of bromine from very large quantities of water. At first they fitted up a ship as a floating chemical factory so as to ensure new water all the time. Later the factory was put on land, the effluent water being run to the other side of an isthmus so that it never mixes with the untreated incoming water. It requires 4,000 gallons of sea-water to yield a pound of bromine, so that a factory making only 50 million pounds, say 25 thousand tons, a year has to pump a great deal of the sea through its apparatus. The sea-water is made of a particular acidity, the right amount of chlorine gas added, and the free bromine so liberated is blown out by a stream of air counter current to the water which is falling down high towers with wooden packing. It is absorbed in soda solution, forming bromides and bromates. The process is continuous and automatic and under instrumental control: it is one of the triumphs of modern chemical engineering design and construction.

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* Paper read at the Conference on Mineral Resources and the Atlantic Charter, arranged by the Division for the Social and International Relations of Science of the British Association, on July 25.

Though in practice the recovery of magnesium metal from sea-water involves comparatively simple operations, it is far from being an easy task economically to utilize a raw material which contains about 1 part of magnesium in 800 of water. Quite unusual chemical engineering methods, equipment and control had to be invented. At the most successful and largest plant use is made of milk of lime, made from large deposits of fossil oyster shells found in the vicinity, to precipitate magnesium hydroxide from sea-water which has been freed from extraneous matter. The hydroxide is collected in special filters and converted into magnesium chloride, using for this operation a 10 per cent aqueous solution of hydrochloric acid which is largely derived from a latter stage of the operation. The magnesium chloride is evaporated and dried until anhydrous, when it is electrolysed in suitable cells to produce metallic magnesium: hydrogen chloride is evolved from the cells. Natural gas is used as a source of power; the effluent water is discharged seven miles from the intake into a current of sea-water which is always in the same direction.

Such, in a paragraph, is a description of a factory which is full of new methods and devices. Magnesium, the lightest of metals, cost a sovereign a pound in 1915 and barely a shilling last year. It is expected that the capacity of a single sea-water plant will be increased to 100,000 tons of metal by the end of this year, which represents an incredible number of gallons of sea-water.

At the same factory, though in a separate plant, bromine is being extracted, and the acid effluent from this mingles with the alkaline effluent from the magnesium to make a largely neutral return flow to the sea.

Magnesium metal was first made around 1869 mainly as a source of high-intensity light for photographic purposes. Later on, sundry uses in fireworks came along. It awaited war to start its use in aeroplanes and in incendiary bombs.

Magnesium in combination is one of the most abundant elements on the earth's crust. The most favoured source is magnesite, which in particular is used for refractories. Other sources are dolomite, where it is associated with carbonate of lime and carnallite. If the metal is to be made by electrolysis, hitherto the favoured process, the magnesite has to be converted into chloride by briqueting the calcined material with carbon and binding substance and exposing to the action of chlorine in an electric furnace. Since in the course of electrolysis chlorine is involved, the process becomes in theory cyclic, although in practice there is waste through formation of hydrogen chloride.

There are also competitive thermal methods for the reduction of magnesite to the metals. The two principal reducing agents are calcium carbide and ferro-silicon. The retorts are either heated externally by gas or internally by radiators. A good vacuum is maintained, and the metal distils in a pure form, only requiring melting. These processes can use dolomite in place of magnesite, merely at the expense of a smaller yield. There are many varieties of these processes, especially in the United States.

Direct reduction by carbon requires a very high temperature, for which an arc is necessary, and the vapour must be rapidly chilled in order to prevent the reversal of the reaction with carbon monoxide, regenerating the oxide. In the original Radenthein process this was done by a jet of compressed hydrogen, cooled to a very low temperature. The magnesium was precipitated as a very fine dust, which had to be melted by high-frequency current without exposure to air. Although much has been heard of this process, it does not seem to have had much success. The Permanente Corporation in California uses natural gas as the cooling agent. The dust is collected, mixed with oil to a dough and distilled. The Ford Co. uses oil as the quenching agent, and a pilot plant of the Dow Co. is using molten lead, from which the magnesium can be distilled.

Magnesite made from sea-water is proving a useful raw material for refractories. If calcined dolomite, a domestic British mineral, is used instead of milk of lime to precipitate the magnesium from sea-water, a double purpose is served and additional magnesium hydroxide obtained.

It should perhaps be mentioned that the production of magnesium metal and of magnesite in the years before the War exceeded the demand: many new uses for the metal will require to be found to absorb the output when peace returns.

Certain minerals reach the sea either from sewage or by the leaching out of cultivated lands. While these in the aggregate total far less than what is produced by denudation, they are of importance because they represent those constituents which are of primary value to man. One of these is phosphate, of which the mineral deposits are limited in amount and likely to become exhausted. Many of the agricultural soils of the world are definitely short of phosphate and their crop-bearing qualities impaired in consequence. It has been calculated that the sewage from 5 million people is equivalent to 17,000 tons of rock phosphate in a year and this quantity is equal to the amount of phosphate in the bones of the annual export of meat from New Zealand. The population of Great Britain discards as sewage yearly the equivalent of 150,000 tons of rock phosphate, most of which reaches the sea.

An estimate of the annual losses of phosphate from all sources to the sea in the United States amounts to the equivalent of 61 million tons of rock. The world's consumption of phosphate rock is said to be 18 million tons.

There is clear evidence that phosphate must be accumulating in the sea, unless it is somewhere being concentrated and deposited.

The chemist is already searching for materials capable of selectively absorbing and retaining substances present in small quantities in large volumes of water. Such base-exchanging materials are widely used in the softening of hard waters and make it possible to take a good deal of the salt out of sea-water, though not enough to make it drinkable by distressed mariners. What is wanted soon is a material which will extract the phosphates and concentrate them to an economic point; the discovery of such an agent should be feasible and may be imperative a generation or so hence.

The advantage of the sea as a source of minerals is that there is free access to it for any country which has a coast-line. Its use, therefore, comes under the fourth clause of the Atlantic Charter. The knowledge of its constituents and its exploitation in the service of man depends upon the progress of scientific inquiry.

The costs of pumping are less than those of mining: on the other hand, the ingredient desired, which may constitute 50 per cent of a land mineral, may be present to the extent of much less than 1 in 1,000 parts of sea-water. A technique of handling large volumes at low cost has to be elaborated before the sea can become a source of minerals.

It is of interest that some plants and animals have the power of concentrating certain of the ingredients of sea-water. Iodine, for example, is present to the extent of 0·001 per cent, whereas the dry matter of deep-water seaweed such as Laminaria contains 0·5 per cent. Kelp, or *varech*, as it is called in France, has been used for many years for the commercial extraction of iodine, even though this practice cannot compete economically with the production of iodate from the caliche in Chile. Certain coral species are said to contain up to 8 per cent of iodine, and it is present here and in the bath sponge in the organic state as di-iodo-tyrosine.

To complete the story we should cite another natural organic halogen compound, Tyrian purple, the purple dye containing bromine derived from a mollusc, which was used to colour the togas of the Imperial Roman Emperors.

The seaweed moves lazily to and fro at our feet as the tide rises; we know what iodine signifies to us though we are without knowledge of what it means to the seaweed.

The oyster concentrates copper, which is another material which may some day be scarce and have to be obtained from the sea. It has been estimated in the United States that 200 tons of copper are lost in sewage every year per million people, together with 50 tons each of such metals as manganese, lead, aluminium, and titanium.

There is an interesting organism, a holothurian or sea slug, found off the Cornish coast, which has the power of concentrating vanadium in its structure, though the quantity in the neighbouring rocks is very minute.

A balance sheet between land and sea is instructive as showing the loss each year of considerable quantities of the rarer minerals. They must either be accumulating in the sea and be available for recovery, or being deposited to form new areas of sedimentary rocks.

It is on record that for a whole month the very minute traces of gold in sea-water were recovered at the great plant which extracts bromine. The gold was there, but at a cost several, stated to be four, times its value, so that the mines of South Africa need not feel anxious.

Probably many experiments are in hand to extract coveted minerals from the sea. The chemist can do it, but at a cost which may not be competitive with a land source provided that this is accessible. The way to deal economically with large quantities has been shown. To solve such problems three things are essential: first, skilled chemists and chemical engineers, products of the universities; secondly, immense quantities of cheap electric power; and thirdly, a cheap source of heat. A country unable to provide any of these will fall behind in the race to produce even if it has 'free sea' available.

OBITUARIES

Prof. E. Fawcett, F.R.S.

THE death on September 22 of Edward Fawcett has taken away from British anatomy yet another outstanding personality. A fine figure of a man, his carriage was always firm and erect, even in old age; and this bodily vigour was the physical counterpart of a robust and active mind.

Born in 1867, he graduated M.B., C.M., at Edinburgh in 1889, and his interest in anatomy was already shown in his student days, for he was demonstrator of anatomy in the School of Medicine for two years before he qualified. He spent three years at the Yorkshire College, Leeds, and after this brief interlude proceeded to his permanent home in Bristol. In 1893, at the age of twenty-six, he was appointed professor of anatomy in University College, Bristol, and in that capacity he served until his retirement in 1934, when he was made emeritus professor. For a large part of that time (1905–34) he also served as Dean in the Faculty of Medicine. For practically forty years, therefore, he was associated with the Bristol Medical School as a whole, and the Anatomy Department in particular, and in the development of both he took an exceedingly active part. He was elected a fellow of the Royal Society in 1923.

As an anatomist Fawcett was held in high esteem by his colleagues. He was successively vice-president of the Anatomical Society of Great Britain and Ireland (1913), treasurer (1914–25), and president (1927–29). At the Budapest International Medical Congress (1909) he was president of the Anatomical Section.

From a review of an extensive list of published papers, Fawcett's work may be seen to fall, with some overlapping, into four main periods. In the first period he was interested in bones and joints generally, but the interest gradually narrowed down to problems of bone growth and formation of epiphyses. This second or epiphyseal period passed over to the third, in which interest was focused more especially on the development of individual bones of the skull. This led, naturally, to the fourth and most important period, when he published his researches on the growth of the mammalian chondrocranium. It is the work done in this fourth period which constitutes his most important and fundamental contributions to biological science.

During 1917–23 he published in rapid succession detailed accounts of the primordial cranium of a number of mammals: Microtus (1917), Erinaceus (1918), Poecilophoca (1918), Miniopterus (1919), Tatusia (1921), Xerus (1923), and Homo (1923). All his work was marked by scrupulous honesty and an unremitting attention to detail. Both his histological and reconstruction work were of a uniformly high technical order.

Briefly to epitomize Fawcett's work, one may say that he enlarged our knowledge of the development and morphology of the bones of the facial skeleton, and made fundamental and extensive contributions to our understanding of the detailed anatomy of the mammalian primordial cranium. His researches under this head are classical, and will remain as a permanent contribution to vertebrate morphology. Various pieces of lesser work, such as those on the development of the clavicle, the epiphyses of the axial skeleton, and the ossification of the sacrum, also constitute a lasting addition to our knowledge of osteology.

However, Fawcett possessed such a superabundance of energy that his anatomical labours, considerable as they were, by no means exhausted it. In 1919 he founded the Bristol Spelæological Society, and held office as president from its foundation until 1936. He published numerous reports on human skeletal remains submitted to him for examination, and indeed at the time of his death two such reports were awaiting publication, one dealing with remains associated with a beaker at Corston, Somerset, the other with some human bones from a Roman stone coffin exposed during the recent air-raids on Bath.

During his latter years, Prof. Fawcett was engaged in work of an archæological nature, in which he took great delight. As in his anatomical, so in his archæological work, he was influenced by two factors, the consideration of form and of development. He made a study of the ancient chairs to be found in Bristol and the surrounding counties, and arranged them according to their structural evolution. The same principles made him an accurate student of medieval architecture, for he made detailed observation of mouldings and other architectural features, and so was able to fix the date of a building or part of a building with authority.

He made complete lists of the achievements of royal arms in churches in the counties of Somerset, Gloucester and Wiltshire, and the City of Bristol, and he knew the arms of every family living within thirty miles of Bristol. His eye for detail led him to be the first person to record the anthropophagous figures which appear, often at a great height from the ground, on the external fabric of some churches.

Prof. Fawcett leaves a widow, a son, and a daughter.

J. M. YOFFEY.

Dr. Leonard Klatzow

THE death of Dr. Leonard Klatzow occurred on September 22 at the age of thirty-five. Dr. Klatzow was educated in South Africa, and came to England in 1930 as a Rhodes Scholar, obtaining his D.Phil. after three years' research work at the Electrical Laboratories, Oxford, during which he published several valuable papers in collaboration.

In 1934 Klatzow entered the research laboratories of Electrical and Musical Industries, Ltd., at a time when experimental development of high-definition television was beginning. The successful establishment of the London Television Station owed a considerable part to the improvements arising out of his work on photo-electric surfaces and allied subjects; among his colleagues he acquired an enviable reputation as a master of this difficult and delicate art. He maintained, as is not always easy in an industrial laboratory, a close contact with pure science, and was always quick to see the value of academic discoveries for the solving of practical problems. His work, largely unpublished, did not receive the wide recognition it deserved, but there is no doubt that a career of increasing distinction was opening before him.

His lively and generous personality made him a particularly agreeable colleague, at once stimulating and sympathetic, and led him to take a keen interest in the welfare of those around him, especially of the junior staff under his care. The shock of his loss was keenly felt when, at the end of a period of especially intense work, he died suddenly, of a long-standing but unsuspected heart weakness, literally at his post of duty.

B. M. CROWTHER.

THE secretary of the Association of Scientific Workers writes:

The name of Dr. Leonard Klatzow will always be associated, by a large circle of friends and fellow-workers, with the renaissance of the Association of Scientific Workers in recent years. He joined the Association in 1936, at the end of a public meeting held in the Imperial College of Science on "Defence and the Responsibility of the Scientist", and immediately threw himself wholeheartedly into its work. Nobody who met him failed to be infected by his enthusiasm for the Association and the ideas it stood for, which gave full scope for his sense of responsibility to his fellow scientific men and to the community as a whole. His lively imagination, methodical mind and personal charm admirably fitted him for this work, and within a few months he was elected to the executive committee and appointed honorary treasurer, a post which he held for more than three years. In two major enterprises at least he played a leading part, namely, the setting up of the Scientific Films Committee, and, later, of the London Scientific Films Society; and the complicated negotiations which led to the establishment of the Unemployment Benefit Fund for scientific workers.

NEWS and VIEWS

Soviet Scientific Work on Potatoes

A LONG cable has been sent by Prof. Lysenko, president of the Lenin Academy of Agricultural Sciences, to Sir John Russell, chairman of the Anglo-Soviet Scientific Collaboration Committee, describing recent results of Soviet scientific work on the potato crop which in the U.S.S.R., as in Great Britain, is now of very great importance as human food. The message begins by stating that the Odessa Institute of Genetics and Selection, of which he was for a long time director and where much of this work was begun, had been evacuated before the Germans captured the city. The investigations now being made under Lysenko's general direction by various scientific bodies, like all other scientific investigations in the U.S.S.R., are exclusively directed to the war effort; in this case to help the Collective and State farms increase the output of food and raw materials. Genetics, he says, is the science dealing with the nature of the living organism and its reactions to various environmental influences at different stages of its development. The better the laws of inheritance are understood, the easier it is to govern the nature of the plant organism and modify it in any desirable direction, thereby creating new plants possessing characters useful to man.

War conditions have made it necessary greatly to increase the area under potatoes in the U.S.S.R. because they furnish more food and industrial raw material per acre than any other crop. The difficulty arose, however, that supplies of 'seed' were insufficient to allow of much expansion. The shortage was overcome by using potato tops in place of seed, and methods for their preparation and planting were elaborated. In 1942 a total of 150,000 *ha* were thus planted in various parts of the south-east and centre of the U.S.S.R. and the yields were not inferior to those of potatoes planted in the usual way, and in regions where ring rot is prevalent plants grown from tops were less liable to the disease than those grown from seed. During the winter, extensive preparations are being made to collect potato seed material from Government and public vegetable stores and from private houses to ensure considerable enlargement of next year's potato area, and meanwhile the scientific workers are continuing work on collection of the tops and on their storage and preparation for planting. A request has been sent to Lysenko for details of the methods adopted.

Another method of increasing production in the southern regions, based on Lysenko's own work, is to arrange for two sowings of potatoes in one season. The old method was to sow in April, but the high June temperature led to poor crops of small tubers. The difficulty was overcome by planting in July; the crop is not large but as seed it is much better than the original seed, and, planted in the following April, it gives considerably higher yields. Seed for the July planting, however, cannot in the hot southern regions be kept over from the previous year; on the other hand, the freshly gathered seed does not readily sprout; a period of rest is necessary. Investigation showed that the length of this period depends on external conditions, particularly on the extent to which air can gain access to the plant nutrients contained in the tuber. Access of air is prevented by the skin, and when this is removed sprouting rapidly occurs. The technical problems associated with the large-scale application of this simple device have been worked out, and during the summer of 1942 experiments were made on collective farms and individual plots in irrigated areas of Central Asia, the results of which will enable the potato area of the southern regions to be greatly expanded in 1943. In conclusion, Prof. Lysenko stated that the problem now confronting us is to make the utmost use of our knowledge of the laws governing the development of plants so as to obtain he largest possible yields of the best quality crops from our fields.

Reconstruction Research

The third number of *Agenda* (London: Oxford University Press. 6*s*. quarterly) is notable for the aluable article on "Reconstruction Research con- ucted in Britain by the European Allies", by Ethel J. Lindgren. This article contains almost the first full account of the origin and character of the London International Assembly established as a result of the initiative of the League of Nations Union in the ummer of 1941, for purposes of study, discussion and a free exchange of views as private individuals nd not as representatives of Governments or parties. Of the five commissions established in November 941, only the first is concerned with a war-time roblem, namely, political warfare. The second deals with the trial of war criminals and to the third was legated future international organization and curity against war, and to the fourth social and onomic reconstruction. By the end of January 942, four sub-commissions had been appointed, ealing with collective security, international organ- ation, economic and financial problems and labour and social questions. The fifth is a joint commission of the London International Assembly and the Council for Education in World Citizenship on the place of education, religion and science and learning in post-war reconstruction. The last to be set up, its membership is large and keen.

No section of the London International Assembly constitutes purely or mainly a research organization, but it provides allied research workers, statesmen and responsible persons interested in international affairs with a focus and a forum where the fruits of research and trends of thought and policy can be brought together. The need for documentation and information is supplied to some extent through facilities afforded by the Royal Institute of International Affairs at Chatham House, and a liaison officer maintains contact between the work of the two organizations. The Allies can, moreover, draw on research carried out by their Governments and on a number of other institutions which are described. These include the Allied Post-War Requirements Bureau, the scope of which was indicated at the Inter-allied Government meeting at St. James's Palace in September 1941, and groups like the New Europe Circle, the membership of which is drawn from about nine European countries, including Civil servants, business men, engineers, students and journalists.

Brief reference is also made to the work of the National Institute of Economic and Social Research, the Nuffield College Social Reconstruction Survey and to various branches of the work of the Royal Institute of International Affairs. The paper includes accounts of various allied institutions such as the Belgian Commission for the Study of Post-War Problems, the Czechoslovak Research Institute, Fighting French Service d'Études de Documentation et de Liaisons, the Statistical Research Section of the Greek Ministry of Finance, official research under the Ministry of Justice, Luxembourg, the Study Group for Reconstruction Problems of the Netherlands, the Polish Research Centre, the Jugoslav Post-War Reconstruction Committee and research carried out by a number of Norwegian ministries, the co-ordination of which is now being discussed. The same number contains a review of research concerning some post-war domestic problems of the United States, which gives an account of the activities of the National Resources Planning Board. Seven fields of exploration as elements of a post-war programme have been suggested by the Board, covering demobilization, public works, industry, expansion of Service activities, security, finance and international activities.

Post-War Planning in the United States

A pamphlet on post-war planning entitled "After the War—Full Employment", by A. H. Hansen, which has been issued by the National Resources Planning Board, suggests that the American Government is making systematic attempts to prepare its people for post-war problems. It is also of interest as indicating the present outlook in the United States on post-war problems. While stress is laid upon the importance of retaining freedom of enterprise, freedom for collective bargaining and for co-operative action, as well as of choice of occupation, the importance of planning for full employment and to prevent a post-war depression is recognized. A shift towards a higher consumption economy is visualized. Points in a Government programme for this purpose include extensive research in industry, in the universities and in Government bureaux to develop new products and processes, the improvement of educational standards and the technique of production and distribution and of transport, building and public health.

The expansion of expenditure on public welfare, including old-age pensions and family allowances, is suggested, and the importance for international co-operation of pursuing internal policies designed to promote active employment as well as for the development of backward countries and for implementing ways and means to open outlets for foreign investment, promote world trade and the world-wide use of productive resources is recognized. With regard to the war period, a policy of high income and excess profits tax with a broadening of the individual income-tax base and steeply graded surtax-rates is advocated, as well as the part-payment of wages and salaries in defence bonds and a sharp increase in excise taxes on commodities competing with the war programme. In the post-war period a policy of retaining the progressive tax structure and broadened tax base with a major emphasis on the individual income-tax and less reliance on the corporate income-tax is suggested, together with a sharp reduction in defence consumption taxes and adequate plans by private enterprise for investment in manufacturing plant and equipment, railroads, public utilities and housing.

The Third Earl of Rosse and his Telescopes

MR. M. A. ELLISON has described (*J. Brit. Astro. Assoc.*, **52**, Sept. 8, 1942) the celebrated experiments of William Parsons between 1827 and 1845 for the improvement of reflecting telescopes. The earlier workers in speculum metal had jealously guarded their secrets of grinding and polishing, and each step in the process had to be established anew by experimenters. The earliest researches of Parsons were undertaken to determine the composition of speculum metal, which should possess the qualities of whiteness, high reflectivity, and resistance to tarnish. It was found that the conditions were best realized in an alloy of four atoms of copper to one of tin, and specula differing to a slight degree from this proportion of the alloys were found to dim rapidly, though they were quite brilliant when polished. Unfortunately, this alloy was liable to shiver at the slightest blow or sudden temperature changes, and attempts to cast it in disks more than about a foot in diameter were abandoned.

A description is given of the different telescopes—the 3-ft., the 6-ft., and the 18-in. reflectors—and also of their mountings. There was a general impression that the 6-ft. reflector had an altazimuth mounting. Actually, the movements of this telescope were equatorial, but they were limited to one half-hour on each side of the meridian. It is interesting to notice that γ_2 Andromedæ was used as evidence of its defining power. Robinson records that he saw the system distinctly, as two neatly separated stars, under a power of 828. The separation at this time (1845) was about 0·5″. The paper concludes with a list of assistants at Birr Castle Observatory and a short account of their work.

Indian Precious Stones

THE Geological Survey of India has recently commenced the publication of a series of Bulletins of Economic Minerals as a war-time measure to direct attention to India's mineral resources. Those issued in 1941 deal with chromite, strontium minerals, phosphates and clay, and several others are in preparation. No. 6 (1942), "Indian Precious Stones", by Dr. L. A. N. Iyer, is a useful pamphlet of fifty-four pages, with two plates illustrating the mining of ruby at Mogok in Burma. It rather gives the impression of a hasty compilation from scattered sources of information; but some additional matter is given relating to the Mogok "stone tract", where the author was engaged in the production of the Geological Survey maps. There, in addition to ruby, a considerable variety of minerals of gem quality has been found. Apart from these, and the sapphire of Kashmir and the many gemstones of Ceylon, there are really few occurrences of importance in India proper, except for semi-precious stones such as agate and almandine garnet.

At one time, however, India was the only known source of diamond, and many of the famous stones found centuries ago are of Indian origin. (One of these, known as "The Moon of the Mountains", was sold by auction in London in August 1942 for £5,200.) At the present time the production is very small, averaging for the years 1929–33 less than 1,500 carats (300 grams) and valued at 74,040 rupees (£5,555), the bulk of this coming from Panna State. It would be interesting to know how many persons, working by primitive methods in small and scattered pits, were engaged in producing this handful ($\frac{2}{3}$ lb.) of small diamonds. They would be of no use in the trade as industrial diamonds. India is actually a large importer of diamonds for jewellery purposes. At one time India was also the sole producer of corundum (of which ruby and sapphire are colour varieties of gem quality) for abrasive purposes, and in fact the name corundum is of Indian origin, but the present output is again very small.

Refrigeration of Fish in Australia

AN account of the application of refrigeration to the Australian fishery industry has been published by the Council for Scientific and Industrial Research (Commonwealth of Australia: Division of Food Preservation and Transport. Circular No. 4.–P, Melbourne 1, 1942). This is written in non-technical language and has been prepared to serve as a guide to the fish industry on the basic refrigeration requirements. As the result of a survey of the important fishing centres along the south coast of New South Wales and some centres in Victoria and Tasmania, it was found that it was possible to catch in eastern Australian waters considerable supplies of fish suitable for an important canning industry as well as for a substantial trade in fresh fish. Serious difficultie must, however, be overcome before any great expansion can take place. These notes are issued as a guide to future development based on the necessity for preserving fish by refrigeration to meet the requirements of a large and stable industry.

Tin Economy in Cable Jointing

A NEW type of wipe or fillet joint is described by J. T. Lowe (*Bell Lab. Rec.*, **20**, No. 11, July 1942) which makes it possible to meet the essential requirements for a wiped joint using far less solder without the necessity for a new wiping technique. Essentially, the new method consists of carefully beating in the cable sleeve ends to the proper shape to facilitat formation of a satisfactory fillet of solder and to obviate rounding out the sleeve ends with solder

Tests of strength, resistance to fatigue and gas-tightness show the new joints to be fully as good as the old. The wiping technique is somewhat simpler and is well liked by jointers. The adoption of the new technique reduces the amount of tin the Bell System would ordinarily need for wiping solders by more than 60 per cent.

Distribution of the Stars

DR. BART J. BOK, of Harvard, has made a report (*Sky and Telescope*, August) on one of the first results of work by the so-called "star-counting circuit", which is an informal organization of several observatories in the United States and other countries. A search was made for comparatively unobscured regions along the Milky Way, and several fields have been discovered in which the light of the distant stars is only slightly dimmed by the absorption of interstellar matter. The most notable clear regions are in the constellations of Cepheus, Auriga, Monoceros, Carina and Centaurus. In the portion of the Milky Way which lies between the southern Coalsack and Cygnus, in which the star clouds of Sagittarius and Scutum fall, there are no regions which are relatively unobscured. Even for the brightest patches in this section the light of stars at 3,000 light years from the sun is dimmed by a whole magnitude. It appears that the stars of different spectral classes are not well mixed in our part of the Milky Way. It is remarkable that there is a rapid initial decrease in star densities for all classes in the direction of the galactic nucleus, and at 1,000 light-years from the sun the densities are very low. Higher densities are not found for the central regions until we reach three to five thousand light-years from the sun.

Bibliography of Seismology

THE present number of this important bibliography (13, No. 11, January to June, 1942), published at the Dominion Observatory at Ottawa by Ernest A. Hodgson with the assistance of four collaborators, maintains its previous high standard. There are seventy-seven items culled from world-wide sources covering topics from the strength of rock materials to world structure. Many items concern patents for geophysical prospecting such as item 5326, Williams, P. S., "Seismic Exploration Method", U.S. Patent 2,253,358, Aug. 19, 1941, and Beers, R. F., "Means for Analysing and Determining Geologic Strata", U.S. Patent 2,249,108, July 15, 1941. Items from NATURE and *Science News Letter* are included. There has been some discussion recently concerning the geology of the beds of the oceans especially near shore-lines. This enhanced interest is mirrored in item 5313, Jones, O. T., "Continental Slopes and Shelves", *Geographical Journal*, 97, No. 2, 80–99 (London, Feb., 1941); and in item 5341, Shepard, Francis P., and Emery, K. O., "Submarine Topography off the California Coast", Geological Society of America Special Publications, No. 31, 171 pp., 4 charts, 18 pl., 42 fig. (New York, 1941). Reginald A. Daly made a contribution to NATURE concerning "Glaciation and Submarine Valleys" on Feb. 7, 1942 (pp. 156–60), item 5291.

Earthquakes Registered in New Zealand

DURING June 1942, eight large earthquakes were registered by the seismographs at Wellington, Auckland, Christchurch and Arapuni, according to Provisional Bulletin No. P–124 of the Dominion Observatory, Wellington. Two prominent shocks were on June 6 with epicentre east of the New Guinea region and focal depth about 100 km., and on June 24 at Wairarapa. Thirty-one local earthquakes were recorded during the period, including the Wairarapa shock mentioned above. This reached intensity 7 on the instrumental magnitude scale (New Zealand Bulletin P–104, p. 3) and was followed by nine principal aftershocks and about 418 minor shocks. Several of the aftershocks reached intensity 4½, and on June 25 an earthquake of intensity 4 was felt at Hokitika.

Research in Industry

IN connexion with the discussion of the relation of academic and industrial scientific research, Mr. Foster Sproxton has raised the question, in correspondence, of the position of the smaller industries which have no research associations. They may have problems arising in chemistry, physics, the various branches of engineering, or problems involving the biological sciences, outside the field of the regular scientific staffs employed at the factories. Guidance in the choice of an academic consultant would be of the greatest value in such industries. Mr. Sproxton believes that some kind of panel of academic scientific workers willing to assist in the solution of industrial problems would be of service, and suggests tentatively that such a function might form part of the activities of the Central Register.

Dr. Gustav Retzius

DR. GUSTAV MAGNUS RETZIUS, a celebrated Swedish biologist, was born at Stockholm on October 17, 1842, the son of an eminent anatomist. He received his medical education at Uppsala and Stockholm, and qualified at Lund in 1871. Six years later he became 'extraordinary' professor of anatomy at the Caroline Institute at Stockholm. In 1889 he was appointed full professor, but resigned in the following year in order to devote himself entirely to scientific research, particularly in anatomy and anthropology, for which he travelled extensively in Europe and America. Most of his work was concerned with naked eye and microscopical anatomy, but he also made studies in embryology, anthropology, zoology and botany, so that he was a biologist in the fullest sense of the term. Between 1876 and 1906 he published six illustrated folios, the first of which was devoted to the anatomy of the nervous system and connective tissue, the second and third to anthropology, the fourth and fifth to the brain of man and monkeys and the sixth to the organ of hearing. His name has been given to parallel brown lines crossing the enamel-prisms of the teeth seen on cutting the enamel, and, with that of Key, to two foramina in the brain. He was awarded many prizes for his work, including the Montyon Prize of the Institut de France. He died on July 21, 1919.

DR. WILLIAM BRADLEY, lecturer in tinctorial chemistry and dyestuffs in the Manchester College of Technology, has joined the scientific staff of the British Drug Houses Ltd. His research work in organic chemistry includes the disclosure of the mechanism of the so-called Nierenstein reaction, the development of the theory of aromatic substitution by anionoid reagents, and the advancement of the chemistry of the anthocyanidins and of benzanthrone.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Saqqara Graph: its Geometrical and Architectural Significance

THE Saqqara graph, drawn on an ostrakon, has been described by Gunn[1], and discussed by Clarke and Engelbach[2]. Jarrett Bell[3] has suggested that ordinates of the dimensions written on the ostrakon can be obtained by drawing, in a quadrant of a circle of radius 9 cubits 1 finger (253 fingers), a line parallel to the base and 155 fingers from it, and on this line erecting ordinates spaced 40 fingers apart. (The length of this base line is thus 200 fingers.) His results are tabulated thus:

Height of ordinate of arc of circle as calculated	98	94·8	85	67·7	41	0
Height given on ostrakon	98	95	84	68	41	0

(The '84', differing from 85, is explained as probably due to careless measuring, or writing 3 cubits for 3 cubits 1 finger.)

These results seem to confirm Jarrett Bell's suggestion. I found some dissatisfaction, however, in the fact that the figures 155, 253 and 200, though connected, of course, by the Pythagorean relation $(253)^2 - (155)^2 = (200)^2$ approximately, have no *simple* relation to each other such as one might expect an Egyptian to have used. I therefore tried a base line the length of which was exactly four fifths of the radius.

In Fig. 1, OR, the radius, is 5 units, and XY, the base line, is 4. By Pythagoras' Theorem, $OX = 3$, so $aX = 2$. The lengths of the other ordinates b, c, d, e, which are 0·8 units apart, are given by y in:

$$(y+3)^2 = 5^2 - 0{\cdot}8^2;\ 5^2 - 1{\cdot}6^2;\ 5^2 - 2{\cdot}4^2;\ 5^2 - 3{\cdot}2^2.$$
$$= 24{\cdot}36;\ 22{\cdot}44;\ 19{\cdot}24;\ 14{\cdot}76.$$
$$y+3 = 4{\cdot}936;\ 4{\cdot}737;\ 4{\cdot}386;\ 3{\cdot}842.$$

The ordinates, a, b, c, d, e, are therefore 2; 1·936; 1·737; 1·386; 0·842.

On multiplying these by 49, to change 2 to the required 98, these figures become: 98; 94·9; 85·1; 67·9; 41·3.

These results are as close to the ostrakon measurements as are those of Jarrett Bell, and, in view of the simplicity and significance of the geometry of Fig. 1, it would seem that the ostrakon measurements were derived from a similar figure. To obtain the lengths 98, 95, 85, 68, 41, as direct measurements from a circle, the radius, OR, should be 245, that is, 5×49, OX 147 and XY 196. A modern mathematician might expect the Egyptian to have used round numbers like 250, 150, 200. These numbers, indeed, are suggested by Jarrett Bell's 253, 155, 200, and, being in the proportion 5 : 3 : 4, satisfy the geometry of Fig. 1. The Egyptian, however, might find occult significance in 245, 147, 196, since they are the respective products of 5, 3, 4 by "seven times seven". On the other hand, these numbers may have come out of the circumstances for which the graph was drawn on the ostrakon. The curve of the graph apparently gives the shape of a saddleback construction near which the ostrakon was found (Clarke and Engelbach).

It is instructive to consider the possible use of the circle of 5-unit radius, that is, Fig. 1, in connexion with the construction of a required arch. The architect would first fix the height of the arch, h, and the length of its base, $2b$. He would then draw the system of squares on which he was accustomed to work, making the distance between successive parallel lines equal to $\frac{1}{2}h$ (see aP in Fig. 1). He would then mark a and X, two squares apart, with P midway between, and O three squares from X; also Y, four squares from X, and the symmetrical point Q the co-ordinates of which are (3, 4). He would thus have found four points on the quadrant, which could then be drawn, ordinates being added as required. I see no reason why the ordinates should be limited to five in number. In any event their lengths would be read off, and ordinates of this length erected at equal intervals along a line of length b.

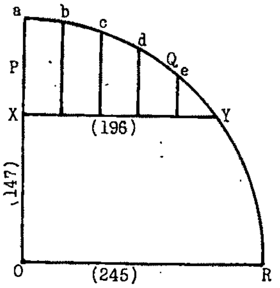

Fig. 1.

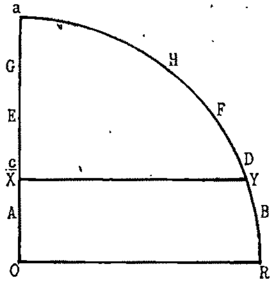

Fig. 2.

This method could be adapted to suit any position of the base line XY. Thus (Fig. 2), h being known, aX $(= h)$ would be drawn and O arbitrarily fixed. aO would then be divided into five equal parts, and the system of squares drawn. F and H would be found by their co-ordinates (4, 3) and (3, 4), and the figure completed as before. The nearer XY is to OR the more rounded will be the arch at its ends, and the more curvilinear generally.

Capart[4] points out that the Egyptian artist used his system of squares to provide a canon for the drawing of human figures. Bearing this in mind, one can imagine a canon of arch construction in which the position of the base line XY would be limited to five possibilities, namely, OR, AB, CD, EF, GH (Fig. 2), which lie on consecutive lines of the system of squares. At a later period this scale of base lines might be abandoned, as the historic diatonic scale has been abandoned by the atonalists of to-day, in favour of a freer canon under which any line parallel to OR served as base line.

As regards the geometrical significance of the Saqqara graph, it is shown that the construction of the circle of 5-unit radius is facilitated by using the fact that points with co-ordinates (3, 4) and (4, 3) lie on its circumference. Since the Egyptian architect constantly used a squared surface, it seems reasonable to suppose that he knew this fact, which depends on the rectangular property of the triangle of sides 3, 4 and 5 units. The Saqqara graph is geometrically important because it furnishes definite evidence of this knowledge, if my suggestion that it was evolved from a base-line of four fifths of the radius of a circle is accepted. Thus we arrive at the interesting conclusion that the geometrical basis of the Saqqara graph, and possibly of a canon of arch construction, is the right-angled triangle of sides 3, 4 and 5 units.

This triangle was therefore probably known to the Egyptians as early as the fifth millennium B.C., as the ostrakon is ascribed to the Third Dynasty.

R. S. WILLIAMSON.

Graywalls,
Okehampton,
Devon.

[1] *Annales du Service des Antiquités de l'Égypte*, 26, 197–202 (Cairo, 1926).

[2] "Ancient Masonry", 52–53 (London, 1930).

[3] *Ancient Egypt*, 103 (Sept./Dec., 1933).

[4] "Egyptian Art", 156.

Function of the Kidney in Dehydration

ONE of the minor consequences of total war is the resurgence of classical physiological problems, such as the effects of hæmorrhage and of dehydration. Although pure dehydration, in the sense of a deficiency of water but not of salt, is rarely met with clinically, it is precisely this disturbance which presents itself in desert warfare, and in lifeboats or on rafts. One aspect of dehydration which has received much less attention than it deserves is the function of the kidney. Very little urine is formed, and it might have been anticipated that there would have been interesting changes in its composition, and possibly in its mode of secretion. There was the possibility, for example, that a shortage of water in the organism might lead to a diminished blood flow to the kidney, or a diminished glomerular filtration rate.

The urea, inulin and diodone clearances have been letermined in four men who had abstained from all water for three or four days, while taking a dry diet upplying adequate protein, calories and salt. They had lost 4 per cent to 7·2 per cent of their body weights. The results are shown in the accompanying table.

Subject		Volume of urine (c.c./min.)	Inulin clearance (c.c./min.)	Diodone clearance (c.c./min.)	Urea clearance (c.c./min.)
A	Normal	5·70	124	570	66
	Dehydrated	0·66	96	550	20
B	Normal	1·70	119	473	52
	Dehydrated	0·64	99	508	38
C	Normal	1·10	121	470	66
	Dehydrated	0·52	107	615	35
D	Normal	0·95	130	670	77
	Dehydrated	0·55	128	765	39

As was to be expected, small volumes of urine ere passed during dehydration, and the urea clearnces were correspondingly reduced. Three of the en showed a fall of about 20 c.c. per min. in the ulin clearance; but to appreciate this fall in omerular filtration rate in its proper perspective, ne must compare it with the much greater reductions inulin clearance which have been found in diabetic ma[1], alkalosis[2], hæmatemesis[3] and in the dehydraon of young infants with gastroenteritis[4]. The odone clearance, which may be taken to measure nal plasma flow, is much more variable, even in rmal subjects, than the inulin clearance; but our ures did not give any evidence of a reduction in e amount of blood flowing through the kidney. In harmony with this, it has been observed by Nadal *et al.*[5], and confirmed in the present investigations, that there is no hæmo-concentration in dehydration of this degree, so that there can be little alteration in blood volume.

One must therefore consider the kidneys of a dehydrated adult as essentially normal with regard to the amount of blood supplied to them, and in the amount of glomerular filtrate formed. Consequently, the very striking changes in the volume and constitution of the final urine must be determined by tubular activity, stimulated no doubt by pituitary, suprarenal and possibly other hormones.

D. A. K. BLACK.
R. A. MCCANCE.
W. F. YOUNG.

Department of Medicine,
Cambridge.
Sept. 28.

[1] McCance, R. A., and Widdowson, E. M., *J. Physiol.*, 95, 36 (1939).

[2] McCance, R. A., and Widdowson, E. M., *Lancet*, 2, 247 (1937).

[3] Black, D. A. K., Powell, J. F., and Smith, A. F., *J. Physiol.*, 99, 344 (1941).

[4] Young, W. F., and McCance, R. A., *Arch. Dis. Child.*, 17, 65 (1942).

[5] Nadal, J. W., Pedersen, S., and Maddock, W. G., *J. Clin. Invest.*, 20, 691 (1941).

Use of Desiccated Chick Embryo in Tissue Culture Technique

THE successful use of desiccated 9–11-day chick embryo as a source of growth-promoting factor was reported in 1940 (Peacock and Shukoff). Since then, repeated tests have been made with desiccates stored for periods up to 2½ years at 4° C. All the samples tested were equally effective and retained their growth-promoting potency and their capacity to coagulate plasma. Apart from the advantages of essential economy in war-time, the use of dried embryo greatly simplifies the technique of tissue culture and helps to standardize results, as it tends to eliminate any individual differences between embryos, and one batch of desiccate can be used for a long series of experiments. Freezing at 0° C. does not appear to affect the desiccates, but storage in a refrigerator at 4° C. has proved quite satisfactory.

R. I. SHUKOFF.

Research Department,
Glasgow Royal Cancer Hospital,
Glasgow.
Sept. 25.

Potassium, Fermentation and the Cell Membrane

IN a letter in NATURE[1] and subsequent communication to the *Journal of Physiology*[2] there was described, with experimental verification, the principles controlling the accumulation of potassium in isolated muscle. This accumulation could occur to a considerable extent without volume change, and the theoretical position established led naturally to an explanation of the potassium content of the original muscle. Further aspects were considered in later communications[3, 5], Prof. F. G. Donnan also contributing[6, 7].

Viewed in the light of this theoretical development, Pulver and Verzar's description of experiments showing the accumulation of potassium in the initial stage of fermentation in yeast, and its subsequent release[8], is of much interest, as also the recent account of a similar occurrence in bacteria (*E. coli*) by Leibowitz and Kupermintz[9]. These experiments are in fact beautiful illustrations of the principles of potassium accumulation[1,2], and the explanation concerning the potassium exchanges is as follows. The yeast membrane, for example, is permeable to potassium and cations of the same or lesser diameter, but is impermeable to sodium or ions of greater diameter (the sodium ion, as is well known, being larger than the potassium ion from the greater number of associated water molecules). The membrane is permeable at the same time to phosphate but not to ions of greater diameter such as the phosphate esters of hexose or adenosine—and this type of electrolyte permeability need only be postulated for the active or growing cell. When glucose enters from without, it is esterified and the effective product of the concentrations of the potassium and phosphate ions falls within. Phosphate enters therefore and can only do so with potassium, more phosphate is esterified, and the process goes on as long as the esters accumulate and hold potassium in equivalent relation. Meanwhile part of the glucose is synthesized to glycogen, so that more glucose than potassium molecules will have entered the cells. As the fermentation proceeds, the accumulated esters will be again broken down, and ultimately to carbon dioxide, alcohol and phosphate, so that the effective product of potassium and free phosphate ion concentrations becomes greater than at the outset, and potassium and phosphate will leave the cells.

It will appear from this description that an ion as small or smaller than potassium should serve as well, provided it is likewise comparatively unreactive chemically with respect to the mechanisms involved. It has been shown[5] that all the potassium ion can be taken out of yeast under certain conditions and replaced with the ammonium ion, and that such yeast will ferment glucose quite readily, and the cells multiply.

The membrane permeability described above, applying to yeast, and to muscle and other tissues of vertebrates, would seem to be of a general kind, though it may be occasionally altered in cells of a very specialized function. It is, in short, and with respect to electrolytes, the normal or standard pore permeability of the cell membrane, and why it should be so has been briefly considered[3]. Distinct from this pore permeability is what may be termed the wall permeability concerning the passage of substances as solutes through the substance of the membrane. Such substances include the lipoid soluble group and possibly ions like magnesium which may enter into organic combination with cell membrane constituents.

EDWARD J. CONWAY.

Biochemical Department,
University College,
Dublin.
Sept. 28.

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[1] Conway, E. J., and Boyle, P. J., NATURE, 144, 709 (1939).

[2] Boyle, P. J., and Conway, E. J., *J. Physiol.*, 100, 1 (1941).

[3] Conway, E. J., NATURE, 147, 574 (1941).

[4] Conway, E. J., O'Brien, M. F., and Boyle, P. J., NATURE, 148, 662 (1941).

[5] Conway, E. J., and Breen, J., NATURE, 148, 724 (1941).

[6] Donnan, F. G., NATURE, 148, 723 (1941).

[7] Conway, E. J., and Donnan, F. G., NATURE, 149, 383 (1942).

[8] Pulver, R., and Verzar, F., *Helv. Chim. Acta*, 23.

[9] Leibowitz, J., and Kupermintz, N., NATURE, 150, 233 (1942).

Interatomic Distances in Carbon

IN a recent paper, B. E. Warren[1] has developed a mathematical treatment of the diffraction of X-rays from random layer-lattices and has derived the Laue[2] expression for the asymmetrical shape of a cross-grating spectrum line which such a lattice produces. He has also shown that when the dimensions of the cross-lattice are small, they can be computed from the formula

$$\beta = \frac{1\cdot 84\,\lambda}{\varepsilon\cos\theta}, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where β is the line broadening in radians, λ the wavelength of X-rays, ε the dimension of the cross-lattice, and θ the Bragg angle. This means that the particle size so calculated is approximately *double* the size obtained from the well-known Scherrer equation

$$\beta = \frac{c\lambda}{\varepsilon\cos\theta}, \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where c has a value of the order of unity[3].

A further consequence of the Warren theory is that the peaks of the asymmetrical cross-grating spectra are displaced from their positions in the direction of increasing θ by an amount which depends upon the crystal size. The increase in sin θ is given by $\Delta(\sin\theta) = 0\cdot 16\,\lambda/\varepsilon$. Thus the lattice spacing d calculated from the Bragg equation $2d\sin\theta = n\lambda$ would be in error by an amount

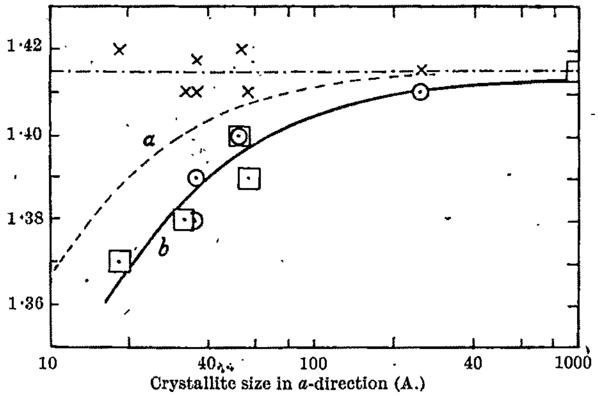
$$\frac{\Delta d}{d} = -\frac{\Delta(\sin\theta)}{\sin\theta} = -\frac{0\cdot 16\,\lambda}{\varepsilon\sin\theta}, \quad . \quad . \quad . \quad (3$$

if the two-dimensional nature of the lattice producin the spectrum line were not appreciated.

A direct test of the validity of equations (1) an (3) can be made by applying them to the data alread available on carbon. U. Hofmann and D. Wilm H. E. Blayden, H. L. Riley and A. Taylor[5] and T Schoon[6] have found that as the *a*-dimension of carbo decreases, there is an apparent *decrease* in the parameter, which would mean that the distance o approach of the carbon atoms in the net planes be comes appreciably smaller by an amount far greate than the normal experimental errors in the measur ments of the diffuse Debye-Scherrer halos. In vie of the extremely strong linkage between the carbo atoms in the net planes, such a large decrease in th interatomic distances is very difficult to understan

This has led me to review these data in the light the Warren formulæ. All the crystallite sizes obtaine by the workers mentioned above have been obtaine by using equation 2 with $c \approx 1$. Now if, in co formity with equation 1, we compute the true lay lattice dimensions ε, which are almost double t *a*-dimensions obtained by the various workers me tioned above, and substitute these new values equation 3, we obtain a series of corrections whi can be applied to the corresponding C–C distanc The results averaged out for a large number of c bons are illustrated in the accompanying gra Curve *a* indicates the earlier values of the C distances plotted against the *a*-dimension obtain on the basis of equation 2, which approach asymptot ally the value of the C–C distance in macrocrystalli graphite. Curve *b* shows the same C–C distan plotted against values of the *a*-dimension obtain with the new equation 1. On applying the correcti to curve *b* on the basis of equation 3, we get almost *constant value* of the interatomic distance result which could not have been obtained from original crystallite dimensions given in curve *a*. T *c*-dimensions of carbon, however, must still be computed from equation 2, since the 000*l* reflexions are not cross-grating spectra.

These results are so reasonable that there can be little doubt that they afford a direct verification of the validity of equations 1 and 3. I have long felt that the existing values of the *a*-dimensions for 'amorphous' carbons calculated from Debye-Scherrer photographs have been much too small. Earlier results seem to indicate that the first stages in the grain-growth of carbon could be associated with rod-like crystallites, whereas plate-like crystallites seem much more reasonable on the basis of our existing knowledge of the grain-growth of crystals. The new cross-lattice dimension equation is in conformity with these latter ideas.



⊡ Mean of Hofmann and Wilm's results[4] on new basis. Curve *b*.

⊙ Mean of Blayden, Riley and Taylor's results[5] on new basis. Curve *b*.

× - - - × C—C distances of curve *b* with Warren correction.

- - - - - Mean curve for C—C interatomic distance on basis of original values given in published data[4,5].

Similar cross-lattice problems may also arise in the study of alloys, where phases precipitate out of solid solution in the form of fine lamellæ, or where two allotropic modifications of the same element, hexagonal close-packed and cubic face-centred cobalt, for example, form successive layers of submicroscopic thickness by gliding along planes perpendicular to a common trigonal axis.

A. Taylor.

Scott Motors (Saltaire), Ltd.,
Shipley, Yorks.

Warren, B. E., *Phys. Rev.*, **59**, 693 (1941).
von Laue, M., *Z. Krist.*, **64**, 115 (1926); **82**, 127 (1932).
Scherrer, P., "Kolloidchemie", third edition, 387 (Zsigmondy, 1920). Jones, F. W., *Proc. Roy. Soc.*, A, **166**, 16 (1938). Patterson, A. L., *Phys. Rev.*, **56**, 972, 978 (1939). Taylor, A., *Phil. Mag.*, **31**, 339 (1941).
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Blayden, H. E., Riley, H. L., and Taylor, A., *J. Chem. Soc.*, 67 (1939); *J. Amer. Chem. Soc.*, **62**, 180 (1940). Taylor, A., *J. Scien. Instr.*, **18**, 91 (1941).
Schoon, T., *Angew. Chem.*, **51**, 608 (1938).

Buddleias on a Bombed Site

The appearance of considerable numbers of plants of *Buddleia variabilis* on a bombed site in Kensington, was recorded in Nature[1], is not an isolated case. During a recent study of the flora of the site of three bombed houses in Kew, numerous Buddleia plants were found. The houses were bombed in the autumn of 1940 and the sites cleared in the following spring. In addition to many weeds characteristic of waste ground there are at least sixty Buddleias. Some of these are 5–6 ft. in height and have bloomed freely; others are smaller plants but many have also flowered. There are no Buddleias in the gardens of these three houses, and I have not identified the parent plant, but Buddleias are present in the neighbourhood though at some distance. Buddleia seeds are extremely small and have certainly reached the site by being wind-blown. The success of the plants is probably largely due to their long, sturdy tap-roots, which have been able to penetrate the hard down-trodden surface material and to reach the sandy subsoil.

Rosamond F. Shove.

13 Burlington Avenue,
Kew Gardens. Sept. 18.

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[1] Nature, **150**, 320 (1942).

Mating Call-note of Moths

A few days ago, a female ground lackey (*Malacosoma castrensis*) was disturbed in daylight from its shelter in canvas in a loggia. It alighted on a table and commenced to vibrate its wings in a very small radial arc to attract the male. Bending low over the moth, I was astonished to hear a powerful, low-toned hum like that of a distant single-engined fighter. As the latter are not uncommon here, the observations were repeated to make sure the ear was not deceived.

Formerly, it has been suggested that the female emitted waves of a length too short to be perceived aurally. I had earlier discovered that this quivering of the wings could be induced by gently stroking the dorsal hairs of the Silver *Y* (*Plusia Gamma*), but on that occasion no aural observation was taken.

N. L. Silvester.

Russell-Cotes Art Gallery
and Museum,
East Cliff, Bournemouth.
Sept. 12.

Nova Cygni (1942)

On September 18 the Norman Lockyer Observatory, Sidmouth, was informed of the discovery by Zwicky of a nova in Cygnus at R. A. 20h. 56m., Dec. + 35·7°, mag. 8. Cloudy sky prevented an observation before September 22. Since this date the region has been photographed seven times on four nights. Clouds prevented more work being done and bright moonlight restricted the exposure time. Only the night of October 1 was clear and steady, and a photovisual exposure of 2h. was obtained.

Photographic and photovisual magnitudes were determined with the help of about twenty standard stars (taken from the H.D. catalogue) and are listed in the following table:

Date	Exp.	*mp*	*mpv*
1942 Sept. 22	7m. 30s.	10·14(±0·18)	10·03(±0·17)
,, 23	20m.	$12 > N > 11{\cdot}5$	$12 > N > 11{\cdot}5$
,, 24	20m.	>12	>12
Oct. 1	2h.		$15{\cdot}5 > N > 14{\cdot}5$

While the exposures of September 22 gave a well-defined star image in 7·5 min., the magnitude decrease was so rapid that no later exposure yielded a measurable image despite increased exposure time: on the plates of September 23 the star image could be easily recognized but not measured; on the plates of September 24 no star image appeared at all, the faintest star magnitude on the plate being about 12 on both dates; the plate of October 1 yielded a recognizable but not measurable star image, the limiting magnitude being 15·5.

There was thus magnitude loss of about 5m. in nine days. So rapid a fading, corresponding to a drop of intensity to one hundredth, occurs very rarely with novæ. A similar steep fall is known only with three novæ: Coronæ (1866)[1], Aurigæ (1892)[2] and Herculis (1934)[3]; the decreases were 4·2m. in eight days, 7·4m. in twenty-three days and 5m. in ten days, respectively. The average magnitude loss (0·5m. per day) is about the same in all cases, except Nova Aurigæ (0·3m.), but the sudden fall of about 1·5m. within twenty-four hours—between September 22 and 23—is equalled only by Nova Herculis between April 3 and 4 (6·2m. to 7·6m.). Thus Nova Cygni seems to resemble Nova Herculis, at least in this part of the light curve.

Note added in proof: On October 11 the Observatory succeeded in getting another photograph of 2h. 15m. exposure time on which the star image was only just visible, and the magnitude must therefore have been equal to or less than 16m.

George Alter.

Norman Lockyer Observatory,
Sidmouth. Oct. 6.

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[1] Huggins, *Mon. Not. Roy. Ast. Soc.*, **52**, 275 (1866).

[2] *Harv. Ann.*, **84**, 136/37 (1920).

[3] Beer, *Mon. Not. Roy. Ast. Soc.*, **95**, 538 (1935).

Functions of the Research Associations

It is difficult to draw valid conclusions from any generalization about "industrial research". It covers a wide field of subjects and an equally wide field of quality. Depending upon the particular industry and the type and size of firm engaged in it, "industrial research" ranges from relatively minor constructional or similar developments right through to real research upon scientific fundamentals. The extent to which the latter is possible by individual firms depends so much upon the extent of the permissible expenditure that the work of the research associations tends also to cover an equally wide range.

Without doubt cases exist where criticism can be levelled at the lack of intimate knowledge of the work of the industry possessed by the staffs of the research associations. It is to meet such deficiencies that I support the suggestion of greater interchange between their staffs and those of the industrial laboratories. Such exchanges would, in my opinion, help both parties; and I would not restrict such interchange to any except the director and his immediate assistants.

Dr. Toy[1] is certainly correct in his statements concerning the essential nature of confidence in the association's staff, but I feel that these staff interchanges should only help to increase such confidence by broadening the knowledge each of the others. Among many industrialists this complete confidence does not exist, particularly when it is known that the association's staff have had no personal practical contacts with the work of the industry. In these instances, the tendency is undoubtedly to confine the association's work to generalities—such as can be guided by a committee.

I do not overlook the very many original and often fundamental researches that have been completed by the research associations; but I am sure that a more free interchange of personnel would aid such work, and would help towards Sir Lawrence Bragg's aim of discovering "the best way of applying our great natural scientific ability to the strengthening of our industrial position".

Philip R. Coursey.

Nutteries,
Liss,
Hants.

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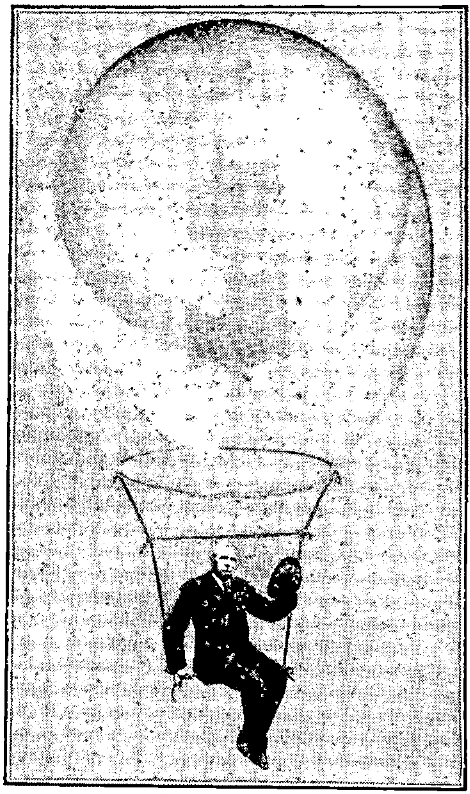
[1] Nature, 150, 373 (1942).

A Flight of Pure Imagination

It is possible that the enclosed photograph and lines might not be out of place in Nature as a sequel to Sir Richard Paget's verses of June 15, 1935. So far as I can remember, I took the photograph some time after the year 1912 when my paper on rotating films appeared (*Proc. Roy. Soc.*, **87**) and the Rainbow Cup became a popular scientific toy. I then intended to get out a third edition of my book on "Soap Bubbles" with the Rainbow Cup as the chief addition, and the idea of the fake photograph occurred to me as being a permissible diversion. Stumbling upon this at the present time, with the Paget verses fresh in memory, the seven lines with the photograph of which three are quoted, flashed across my mind and seemed appropriate for publication. This must be my apology.



"Why does Sir C. V. Boys elect
To do the things we least expect?"
Sir Richard gave the explanation*.
But how? Well, here's an illustration—
"A photograph which cannot lie"
Shows clearly that he does it by
A flight of pure imagination.

I am indebted to Messrs. Kodak Ltd. for the prin from which the figure is taken, in which they have eliminated a blemish in my original negative.

C. V. Boys.

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* Sir Richard Paget, Nature, June 15, 1935.

ENGLISH SOCIAL STRATIFICATION

SOCIAL stratification exists in most societies, yet upon the English it exerts a powerful, subtle and complex influence, to a much greater extent than in younger culture-patterns. Strangely, however, the subject has attracted very little attention from psychologists. Psychologists ought to regard social stratification as a problem to be studied as objectively as a geologist studies the layers in a cliff face. The practical issues are of importance for the welfare of the future*.

Social stratification, however, is not the result of inevitable forces. Already since the War we have seen many changes, changes which are much more difficult to study in a large town than in a village. One classification distinguishes between those with opportunities and those without; in some parts of the country even the probability of living is less than in other more favoured localities, while positions of power and responsibility tend to go to persons chosen from an arbitrarily restricted group. If the diplomatic and civil services are to be made effectively democratic a definite study ought to be made of the requirements, and of the arguments for and against drawing from a narrow group.

Another classification is the social one based mainly on titles, money, ownership of land, education, contrasted with the stigma attached to the performance of manual work. This two-class division of English society means that public life is administered too requently by people who know little at first hand about the life of the general public. Social differences are shown by choice of words and phrases, speech-melody, manners and games, and, to a certain extent, eligion. The solution of many problems in social psychology needs more knowledge of the sentiments and ideals which characterize different social strata; so it is necessary to study the more and the less desirable social phenomena, to find out how, when he causes are not economic, they have arisen. It would be a pity if the lessening of privilege led to a decreasing tolerance of individual differences.

* "Psychological Aspects of English Social Stratification." By T. H. Pear. Reprinted from the "*Bull. John Rylands Library*", 26, No. 2, 942.

DETERMINATION OF EQUILIBRIUM DIAGRAMS BY X-RAY METHODS

A DISCUSSION on the determination of equilibrium diagrams by X-ray methods arranged by the Institute of Physics was held at the Royal nstitution, London, on September 22. The chairman, Sir Lawrence Bragg, pointed out that the meeting was largely due to Dr. W. Hume-Rothery's initiative, and that it might be regarded as a continuation of the Institute's conference on X-ray technique held t Cambridge last Easter.

The opening talk was by Prof. E. A. Owen, Bangor, who was one of the first to apply X-ray methods to the study of equilibrium diagrams in an exact way, is subject being "The Determination of Phase Boundaries in Equilibrium Diagrams by X-Ray Methods". The accurate determination of lattice parameters was begun at the National Physical Laboratory, the initial publication being that of Preston and Gayler on the "Age Hardening of opper-Aluminium", who used a focusing camera. This method has been largely used by Prof. Owen for determining phase boundaries. One of his first publications was "A Determination of the Limit of the α-Solid Solution in the Copper-Zinc System". The results agreed well with those found by the standard metallurgical methods, but copper-cadmium caused more trouble on account of the volatilization of the cadmium. Zinc alloys could also be made by heating a mixture of the powdered metals to the melting point of zinc. Then alloys were investigated in a high-temperature camera, the aluminium-zinc system being studied by this means. Later work by Gayler has confirmed the accuracy of this research, satisfactory results being obtained up to the melting point of zinc. The accuracy of the work depends on the composition and on the lattice parameter. The more rapidly the parameter changes with composition the better the results are likely to be. It is more difficult if the boundary changes very rapidly with increasing temperature, as in the copper-indium system, and accurate temperature control is vital.

In order to make alloys of more reliable composition, Prof. Owen has devised a shaking furnace. The materials are placed in small silica tubes which may be lined with graphite. After shaking for a quarter of an hour or longer, the alloy may be quenched or slowly cooled to obtain very small ingots down to half a gram in weight. Specimens selected from different parts of the ingots were sent away for analysis. There is usually agreement to 0·1 per cent with the intended compositions. The powders from these specimens are sieved before use and heat-treated in an evacuated silica or 'Pyrex' tube. The work has been checked up by a satisfactory comparison of the results from alloys made up by fusion and interdiffusing. Identical parameter measurements have been obtained from powders and from solid specimens.

Extremely reliable results have been obtained even with the silver-arsenic system, no errors due to volatilization being detectable. A very important point is the effectiveness of quenching. A special furnace has been devised by means of which specimens may be quenched in less than two seconds.

The α boundary of the copper-tin system has been determined with an accuracy of 0·1 per cent. Similar results were found for the copper-aluminium system, but there is more difficulty with the silver-aluminium system because the β-phase is not retained, the possible error being 0·4 atomic per cent.

Dr. W. Hume-Rothery spoke on the application of X-ray methods to the determination of phase boundaries in metallurgical equilibrium diagrams. Two types of investigation are valuable: either the determination of a rough equilibrium diagram or the determination of an accurate diagram. For the rough survey it is preferable to use X-rays in conjunction with the older methods, the former for the lower, the latter for the higher, temperatures. There is, however, a possibility that the filings will not behave in the same way as the lumps, particular precautions being required to deal with two-phase alloys, where the powders may give misleading results unless each particle contains both phases in the same proportions.

For accurate work the liquidus and solidus are best determined by the older methods, but for investigating transformations in the solid state the high-temperature camera supersedes thermal analysis provided that the composition of the filings is accurately known. Moreover, the X-ray method is particularly useful for the identification of phases in ternary and other complicated systems.

The older methods are more sensitive for the determination of the precise limits of the phase boundaries, yielding an accuracy of one part in a thousand for the microscope. Prof. Owen's results are invaluable for comparing the X-ray with the microscopic technique. The α-phase boundaries lead to satisfactory agreement, but in the case of the two β-phases there are wide divergencies at the higher temperatures. This may be ascribed to unavoidable decomposition of the filings during quenching, and it is therefore advisable that specimens should be examined by the microscope to test whether they are suitable for the application of the X-ray method.

Work done at Oxford includes an examination of the copper-gallium diagram by X-rays. The β-phase was examined in the high-temperature camera and in the form of quenched filings. At the high temperatures the structure is body-centred cubic, but during quenching it is transformed to hexagonal close-packed. Another difficulty in the use of the X-ray method is that the relation between the lattice spacing and composition within a phase is not necessarily a smooth one. A notable example is the iron-aluminium system; also many systems containing magnesium recently investigated by Dr. Rayner at Oxford. In conclusion, it is now recognized that there are so many pitfalls in the use of X-rays for the exact location of phase boundaries in equilibrium diagrams that help is needed from other methods.

Dr. A. J. Bradley spoke on the examination of heat-treated alloys by X-rays and the microscope. Alloys must be made up from extremely pure ingredients, say 99·95 atomic per cent. The discordant results obtained from the aluminium-manganese system can probably be ascribed to the gross impurities formerly found even in the best manganese available. Errors in the initial composition are not always put right by chemical analysis, for when the amount to be analysed exceeds 50 per cent of the alloy, there may be difficulties in reaching the desired standard of accuracy. Lattice spacing measurements are then a valuable check on chemical analysis.

Before X-ray examination alloys must be lump- and powder annealed. The former gives uniformity, the latter impresses a definite structure on the specimen. Lump-annealing treatment is only effective if carried out just below the final freezing point or solidus temperature. For example, $NiAl_3$, when cooled from the melt, is found to be contaminated with Ni_2Al_3 and aluminium. Lump annealing, if carried out at the right temperature, produces pure $NiAl_3$. Powder annealing is necessary to give good X-ray photographs, as the act of filing or grinding may be enough to change the crystal structure of the original lump; but, on the whole, the annealed powder should correspond more exactly to true equilibrium conditions.

The microscope shows the difference between a single-phase alloy and one containing two or more phases, but only the X-ray method can show with certainty which phase is present. Thus in theory the X-ray method is the ideal means for the investigation of alloy equilibrium diagrams; but at present the microscopic technique, being the more fully developed, is the more reliable. This is especially true at high temperatures, as the high-temperature X-ray camera is still in its infancy.

Heat treatments must be greatly lengthened as the temperature is lowered, but structures which a readily shown up by the X-ray powder method afte a few days heat treatment may be invisible unde the microscope even when the alloy has been heate for weeks, owing to the fine nature of the precipitat When the structure is decomposed during quenchin as in the change from austenite to martensite, combination of the two methods is essential.

Dr. L. M. V. Gayler gave a brief summary of th classical methods used by metallurgists for dete mining equilibrium diagrams. Chemical analysis an essential foundation upon which all physic measurements should be based. The use of X-ra is subject to certain limitations. The liquidus an solidus of a system must first be established by th older methods. There is still much to learn abo the nature of the freezing point. Why do some phas such as CuAl and $CuAl_2$ separate by peritectic r actions, whereas Cu_3Al comes directly from t melt? X-rays have been very little used on suc problems.

Small amounts of fine-grained precipitate, thoug identified by the microscope, may be insufficient t register on the X-ray film; but X-rays are of co siderable use in identifying unknown phases ternary systems, even if they sometimes overlook th presence of a phase which has been seen micr scopically. This is not improbable when there a two phases present with the same structure, and suc a case occurs in the tin-silver-mercury syste Where there are transformations in the solid, bot metallurgical and X-ray methods are necessary.

When transformations cannot be suppressed b quenching, high-temperature X-ray work is e tremely valuable. It is essential to use X-rays f the examination of superlattices, but it see doubtful whether they should be inserted on a equilibrium diagram. Time may be saved by t X-ray analysis of powders. Cold work, recrysta lization and grain growth are best studied by X-ray Solid solubility limits are readily determined them, but the process of precipitation should also studied by other means. The use of both X-ra and the microscope is like changing the degree magnification, and both are essential.

Sir Lawrence Bragg then discussed the value equilibrium diagrams, and pointed out that t essential fact is not the exact boundary, as th depends largely on accidents in the previous he treatment, but rather what possible phases m exist. Neither is the equilibrium diagram direct used in industry, as all industrial materials are o of equilibrium. One possible criticism of the X-r powder method is that industry is more interest in metals in the lump form. Their gas content important.

Dr. D. Stockdale emphasized the importance purity, equilibrium, analysis and the method examination. More than one method should be use especially to check up changes of phase duri quenching. For example, in the aluminium-copp system, the microscope gives more reliable resul than the X-ray method for the β-phase, but t silver-copper system gives identical results by eith method. Where there are discrepancies it will oft be found that in the earlier work pure metals we not available, or insufficient precautions were take

Mr. D. A. Oliver stated that extreme accuracy scientifically important but that the practical m would like to have a collated system of diagra revised every five years. While it is desirable to u a variety of methods, X-ray work has yielded brilliant results. Dr. H. Lipson gave an example in direct conflict with the theory of phase equilibrium, that of the metal cobalt. The purity of the metal was 99·99 per cent, and yet it was not possible to find a definite transition point. On cooling, the hexagonal form begins to appear just above 300° C. and the amount increases down to room temperature. On reheating, it only changes back to the face-centred cubic form above 400° C.

Mr. G. D. Preston pointed out that X-rays can give additional information not available by the microscope. The mechanism of phase changes is most important. Dr. G. V. Rayner supported accurate work in order to supply reliable data to the theorists. He agreed that the X-ray method would often give results just as accurate as the microscopic, but it was no more speedy in operation.

Dr. W. Wrazej described the use of X-rays in the investigation of an iron alloy which showed two distinct groups of crystals on microscopic examination. The problem was whether these belonged to different phases or whether they were merely differently oriented crystals. The back-reflexion method proved that the latter was the true explanation.

Dr. A. H. Jay stated that he had just designed an X-ray camera to work up to 1,500° C. In determining phase boundaries by the lattice spacing method, difficulties were caused by irregularities as in the iron-nickel system. He expressed some scepticism about the value of extremely pure materials; results do not always come up to expectations.

Dr. H. O'Neill, though very interested in phase diagrams, does not consider that extreme accuracy is of vital importance for industrial work. If alloys are examined in the lump form, the polished surface layer gives broadened lines. If this is removed by etching, there is a selective solution and the X-ray results are unreliable. Gas may upset the equilibrium of alloys. It would be interesting to follow the tempering process of steel at 400°–300° C. by means of X-rays. Dr. J. L. Haughton directed the attention of the audience to the value of other physical measurements, such as electrical conductivity and dilatation.

Dr. L. Frommer finds it necessary to investigate his specimens in the form of lumps, because he is trying to follow the industrial process of age-hardening in a complex aluminium alloy. The difficulty is to obtain a useful surface. For this purpose he uses diamond turning and faces up the surface with the diamond. This prevents the surface layer from being distorted as with polishing. Dr. A. H. Jay has used a special method for getting X-ray photographs without powdering. A high narrow slit is used, the specimen being rotated to give continuous lines.

Dr. W. Hume-Rothery then commented on a point raised by Prof. Owen, who showed that the X-ray method follows the solubility curve better than the microscope at lower temperatures, and explained that it only needs more care to improve the microscopic results without waste of time. In answer to a request from Dr. Hume-Rothery for an explanation of intensity methods for determining phase diagrams by X-rays, Dr. A. J. Bradley remarked that the method has been mainly used for the determination of three-phase triangles in ternary systems. It needs three alloys in each triangle to give the approximate compositions of the corners from the relative proportions of the phases present in each alloy. More exact values can be obtained by making a new alloy near each corner. Much less than 1 per cent of the face-centred cubic or body-centred cubic phases can be detected, but it is sometimes difficult to detect the presence of phases with more complex structures. A very large camera would be needed if the structure was of low symmetry. Time is saved when the system contains many triangles.

Mr. C. Wainwright stressed the importance of expert chemical analysis. Mr. N. J. Petch pointed out that there is a vital difference in the behaviour of lumps and powder from low-alloy steels. Often when the lump remains austenitic, quenched filings may contain a great deal of martensite. Dr. A. H. Jay, in agreement with a previous speaker, recommended the electrolytic method of preparing surfaces instead of acid etching, which is not reliable.

Dr. H. Lipson would like to study the liquid state by means of X-rays, but considers that the microscopic method should be left to the metallurgists, while Dr. M. L. V. Gayler pleaded for co-operation between physicists and metallurgists. Emphasis was placed on the difference in behaviour between pure and commercial metals. Prof. E. A. Owen was also in favour of co-operation, and strongly supported the focusing camera.

Dr. W. A. Alexander pointed out some discrepancies between X-ray and microscope results on the nickel-aluminium system. In the copper-nickel-aluminium system there is a decrease in solid solubility as the alloy cools, which is important from the point of view of the hardening of copper-rich alloys. There is supersaturation at low temperatures. Dr. A. J. Bradley suggested three stages in precipitation at low temperatures: the first affects the physical properties, the second the X-ray results and the third the microscope results.

Mr. F. A. Fox urged that the X-ray worker should use the microscope, and Dr. L. Frommer stated that quenched lumps differ from the surface to the interior.

ELECTRICAL ENGINEERS AND THE POST-WAR PERIOD

IN his inaugural address on October 1 to the Institution of Electrical Engineers, Prof. C. L. Fortescue first referred to two aspects of the political and economic conditions likely to prevail in Great Britain after the War. First, a great effort will be made to improve the living and working conditions of the less highly paid members of the community; and secondly, Great Britain will for a long time import a large proportion of essential food supplies and a considerable quantity of the raw materials required for industries.

In discussing the export and import tendencies and in proposing a course of action to redress the balance, Prof. Fortescue considers that one of the first problems to be coped with in the post-war period is the conservation of coal and its more efficient use. In this connexion reference is made to the Weir Committee's report of 1931 on main-line electrification and to the Moore-Brabazon Committee's report of 1933 on the Severn barrage scheme, the provisions of which would save 9–10 million tons of coal a year in the one case and about 1½ million tons in the other. The Caledonian power and the Grampian (Glen Affric) power schemes are also mentioned.

In the domestic sphere an improvement in the efficiency of heating apparatus might play a greater part in the conservation of coal than would the development of the rather scanty sources of available water-power. The possibility of using the energy of the condensate from power stations offers good prospects when planned in combination with intensive horticulture on a large scale and industries requiring considerable quantities of process steam.

Prof. Fortescue outlined the facilities and training which in his view should be made available to young men entering upon engineering careers in the post-war years. The school-leaving age will probably be raised to 15 or 16, and four or five years will be needed after that for training in the sciences and for workshop instruction. A further two or three years should be devoted to subject-matter chosen from engineering practice, mathematics applied to engineering problems, industrial economics, works administration or industrial psychology. The student's final award would depend on the work done during the first four or five years and on the presentation of a satisfactory thesis covering the work of the later years; at the conclusion of this, the student should be ready to take his place in productive industry.

Prof. Fortescue makes a plea for the thorough investigation by engineers of the relative advantages of road and rail transport in Great Britain and also in such other spheres as the public health services and agriculture. The necessary researches would need to be conducted on a national scale, possibly by a national research institution or perhaps an extended Department of Scientific and Industrial Research.

Then there will be the urgent and difficult problem of reabsorbing men into industry from the Armed Forces without dislocating the lives of those who have remained in industry. Tentatively it is suggested that all the younger men in industry be gradually drafted into the Forces, after the War, for two or three years of military duty, their places being taken by men of suitable qualifications now in the Forces. By the time the young men from industry have completed these military duties, industry should be in a position gradually to re-absorb them.

Another problem of the immediate post-war period is that of ensuring that all large schemes of industrial replanning are given adequate consideration by our most capable and far-seeing men; during the first few years after the War reconstruction should be limited to that urgently required for those who are without homes as a result of the War.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Saturday, October 17

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m. and 2.15 p.m.—Conference on "Trace Elements in relation to Health".

Sunday, October 18

Association of Scientific Workers (South Wales Area) (at the Royal Hotel, Cardiff), at 10 a.m.—Conference on "Science for Victory".*

Monday, October 19

Tercentenary of the Invention by Blaise Pascal of the Calculating Machine (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 12.30 p.m.: Luncheon; at 3 p.m. to 6 p.m.: Exhibition of Calculating Machines.

Friday, October 23

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Presidential Address by Colonel S. J. Thompson: "Boilers—Past and Present".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Teacher of Engineering Drawing and Science at the Castleford Whitwood Technical College and Junior Technical School—M. G. Swaine, Education Offices, Smawthorne Lane, Castleford, Yorks. (October 20).

Research Assistant (graduate in Science or Agriculture)—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (October 21).

Teacher of General Science Subjects in the Junior Technical Department of the Mining and Technical College—The Principal, Technical College, Church Street, Barnsley (October 23).

Second Technical Assistant (male)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (October 24).

Clinic Psychologist (woman) at the St. Andrews and Dundee Training Centre—The Director of Studies, Training College, Park Place, Dundee (October 24).

Lecturer (man or woman) in Mathematics and Physics—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (October 31).

Lecturer in Engineering Subjects at the Medway Technical College, Senior Departments, Gillingham.—The District Education Officer, Fort Pitt House, Rochester.

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PHYSICS D

THE CHURCH AS A SOCIAL FORCE

THERE is now widespread recognition that our enemies in this War derived no small share of their strength from their enthusiastic belief in the Nazi and Fascist doctrines which their leaders have inspired. Perverted though these beliefs may be, dangerous and destructive to the finest elements in the spiritual and moral heritage of mankind as these doctrines are, they are none the less held and propagated with the zeal and fervour of a crusade. They cannot be overthrown without a like enthusiasm and intense conviction on our part. The religious faith of the Nazi must be countered with one equally strong and equally capable of fostering devotion and loyalty and commanding sacrifice.

That is one reason why morale is so important in our war effort. Without a full understanding of what is at stake, without real conviction as to the supreme value of those ideas of freedom of thought, of speech, of worship, of association and of investigation which are inherent in the way of life for which we contend, there can be neither the spirit of willing sacrifice, nor the stern endurance demanded either for the speedy overthrow of Nazidom or to support the rigours of a long struggle.

It is futile to attempt to separate the weaknesses which, despite the great achievements of Britain, are disturbingly evident here and there to-day from the cynicism and moral inertia which have held so large a sway in our democracies during the twenty years uneasy armistice. Too long have we derided or despised the very qualities which are the secret of survival in war and in peace. That, far more than our failure to recognize the material menace and to rearm in time, has been our real weakness. This lack of courageous leadership had led to recognition of the need for a moral and spiritual revival long before the fall of France. The need for a moral basis for our war effort has been urged repeatedly since, in such striking books as Mumford's "Faith for Living" and Lord Elton's "St. George or the Dragon", and in a remarkable series of speeches of British and American leaders during the spring and summer of this year.

In the past two decades, man's scientific advance has dangerously outstripped his moral and ethical progress. To bridge the gap is the opportunity of science and religion. The antagonism between the two which marked some of the scientific advance has long since been replaced by the conviction that both have a part to play if man is to regain control over his environment and wield aright the immense powers with which he has been endowed. The conditions for a new understanding and a new partnership between science and religion are already being explored and the very hopes being entertained as to the new world order to be established after the War only make that understanding and partnership more evident.

Whatever the divergence of views as to where the moral basis of our society is to be found, there is no dissent from the necessity of finding such a basis. Moreover, both science and religion have learnt that it is in a democratic order of society that they can find their essential freedom and that their own advance is bound up with the defence of democracy and its adaptation to meet the problems of to-day. Men have come, too, to recognize that they need some living torch to rekindle the flames of devotion, of sacrifice and service, an abiding vision of eternal truths established by human experience, by which to set their course, and some fellowship whereby they can strengthen themselves, face the difficulties and disappointments, the dangers and tragedies which beset their path.

To that recognition the interest aroused by the great meeting at the Albert Hall on September 26, or indeed in the Malvern Conference on which it follows, as well as in the religion and life campaign, bears witness. There could be no more fitting time for the Church to declare the principles which should govern the ordering of society, and what the leaders of the Church may say as to the Christian basis of social reconstruction will be the more readily listened to now that the creation of the British Council of Churches has demonstrated that denominational differences will no longer block co-operation in social work. It is widely recognized that the Church should lay down principles for the conduct of individuals. As the Archbishop of Canterbury pointed out in his address, it is no longer tenable that such principles should not be applied to the groupings in which the lives of individuals are conducted. The Church has not only a right but also a duty to declare the principles of true social life. "What has lately been questioned—though by no means always in the history of Christendom—is the right of the Church also to lay down principles for the conduct of great corporations of people—trade unions, employers' federations, national States, and the like—and to exert its influence not only upon the way in which men and women behave in society, but upon the structure of society itself. But that division between the individual and the social groupings in which our lives are conducted is quite untenable. Our lives are social through and through. It is possible, no doubt, to lay excessive emphasis upon the social as against the individual, as also upon the individual as against the social aspects of life ; but the two are intimately bound together, and whatever touches human life, touches both. . . . And so our first duty is always to proclaim the fundamental Gospel itself, and to call men to heed that, and then to draw out the judgments that are implicit in it upon the order of society we know, and indicate the direction at least in which it seems that our forward move must be conducted."

That much has been recognized by our opponents. It is one of the fundamental reasons for the persecution of the Church both in Germany and in the occupied territories, and for the attempt to suppress freedom of worship and of preaching. There, no less than in Great Britain, men recognize almost instinctively that there are practices in their order of society which are inconsistent with what they have learnt of Christianity, which are contrary to the best that they know, and men have shunned the truth because their works have been evil. The Archbishop of Canterbury directed attention to two points in the ordering of our own society in respect of which the judgment of the Church must inevitably be uttered in condemnation, and they are worth examination as indicating the limitations and difficulties which beset the attempt at a Christian ordering of society.

The first of them is the broken fellowship of our society—what Disraeli in "Sybil" described as "the two nations". Resting upon the materialism of our habitual outlook, it leads to a gross disparity of wealth and poverty which must at all costs be remedied. "So soon as we all desire that every man should have enough before each of us should himself have any superfluity, of course everyone would have enough. If we cared more for justice than for comfort and for luxury, economic distribution would be well on the way to solve itself. There would still be problems to be worked out : we should need the skill of the economists and of administrators ; bu they would find no insuperable difficulties." Such broken fellowship leads also to a lack of leisure which in an age of mechanized industry involves lack of opportunity for a fully human life. To provide for all adequate leisure, with the means to utilize and enjoy it, must be one of our primary aims.

The second point stressed by the Archbishop of Canterbury is another expression of this principle The predominant motive guiding not only the enterprise but also the whole ordering of industry has been what is commonly called the profit motive. This is not simply evil : it can have its own place ; but tha is not the first place, where it may lead to an ordering of economic life which is in fact damaging to th general interest. The report of the Barlow Commission on the distribution of the industrial population could well be cited as evidence of the justice of this contention, and it is noteworthy that the recently published report of the Uthwatt Committee lay down principles in regard to the ownership of lan which clearly embody the Christian conception o stewardship rather than exclusive use. They aim at a combination of the advantages of public ownershi and ultimate control with private initiative, and w should see that they are not whittled away by concession to vested interests.

The Archbishop of Canterbury then suggested that we should seek to organize life so that self-interest may prompt the actions which are of the greatest social service, and after a passage referring to mone and credit in which a rather incautious reference to the banking system has led to some misunderstanding and given his opponents a handle for attack, he developed the major argument that it is for th Church to summon men to a dedication and a fellowship in which social life and worship are linked and men catch the vision and receive the power to rene and rebuild the whole of life. Whatever may be said of Dr. Temple's excursion into the realms of hig finance his speech will be welcomed by the va majority of the nation as evidence that the Church conscious of its great responsibilities, and that it prepared to speak plainly and is not afraid to condem social evils, which should not be tolerated by tho who have a living faith in the Fatherhood of God.

In regard to Dr. Temple's first point, the evil of wide disparities of wealth and poverty is generally recognized. The removal of such disparities is implicit in the sixth point of the Atlantic Charter and in the third freedom of President Roosevelt. What should be noted, however, as Dr. E. Barker emphasizes in a significant passage in his "Reflections on Government", which analyses Disraeli's conception of the two nations, is that no community is really arranged in a number of distinct and distinguishable classes. Social facts do not warrant the belief that there is any unbridgeable gulf between the different social elements present in the modern State.

Here then science and the Church are proclaiming the same truth, and one which as Dr. Barker shows is vital to the existence of democracy. Without it the presuppositions of democracy vanish. There will be no single society; no common terms of debate; the differences of opinion and policy will be too acute and too deep to be bridged. While lifting up her voice against social evils therefore the Church must emphasize her call to a fellowship of service which will give a vision and a sense of values transcending all the numerous divisions and subdivisions which make up society. The driving force of religious conviction and the passion for righteousness must reinforce the execution of our planning as well as guide and inspire its framing.

For that reason alone we might welcome this fresh demonstration that the leaders of the Church are not concerned solely with ecclesiastical matters but also with establishing the social conditions which promote right relations both between man and his Maker and between man and his fellows. If they address themselves to that task with intelligence and knowledge as well as devotion, the Church may do much to assist the cultivation of that temper of accommodation, good sense and persuasion which, as Dr. Barker emphasizes, are essential if democracy is to work. The ultimate issue which confronts us transcends any difference between classes, between parties or parts or sections of the community. It is a war between two mental worlds, between two different spirits and tempers of mind—between that of accommodation and that of intransigence.

The Church and science clearly stand on the same side in that struggle; both have learnt to be patient and tolerant of differences, to accept them as the necessary ingredients of unity, and to seek to achieve it by the method of voluntary adjustment. Where science will supply the untiring dispassionate search for truth, the Church can supply the dynamic passion for righteousness which will see that justice is done. Together they should assuredly prevent that débâcle of cowardice and stupidity on the part of political leaders which was so largely responsible for the disaster of the present War. Prof. Gilbert Murray's comments on public opinion in his article, "The Inevitable League", in the current number of *Agenda* should not pass unnoticed in this connexion.

But there is yet another reason why the emergence of the Church as a social force should be welcomed. It is an indication of a revival of the adventurous spirit which is characteristic of the great ages, as Whitehead reminds us. What is required to-day is not merely moral courage and conviction and the vision of a new order, or even a quickened sense of spiritual values. It is also that spirit of adventure which has been ever characteristic of the advance of science itself. Society cannot move forward unless men are willing to try new ways and to explore new ideas, with all that that implies in breaking with the ways of life or habits of thought of the past. The great days in the record of the Church itself have always been those in which she rose to the challenge of one great opportunity and staked her life on some brave new venture.

No new social order will be built unless we are willing to run risks in the building of it and it is all-important therefore to carry with us into the task those who are ready to risk losses. It should not be forgotten that readiness to risk losses rather than the greediness of individuals for profits has been the mainspring of a free and competitive economy, and that factor must find its due place and expression in our new order though it need not be the first place. What is imperative is that the Church and society must be mindful of their duties as well as of their rights.

That was the central theme of Sir Stafford Cripps's address on "The Challenge of Christianity". While it is not the function of the Church as an organized body to enter the lists of the political parties, to do which would confuse the issues and jeopardize the power of religion, it is for the Church to provide the moral force and the driving power for social and economic development. Christian principles, he urged, should be made so to permeate public opinion that no Government can act against them, and those principles must be related to the social and economic problems of the moment.

The interpretation of the Christian ethic in relation to the present facts of life for which Sir Stafford Cripps calls demands not merely courage and firmness of purpose, but also lucid thinking, and the strength of the leadership of the Church will depend upon the measure in which these qualities are forthcoming. Moreover, like Gilbert Murray, he reminds us pertinently that leadership does not consist in seeking to interpret and then to follow the wishes of the majority, but rather in the attempt to lead and direct popular thought along the channels of wise action. Never more thoroughly than in our recent history was there demonstrated the truth of Sir Walter Scott's dictum that without courage there can be no other virtue, and this is true also of the Church. The fear that the bold teaching of Christian principles and their application to our present society will create a demand for far-reaching social and economic changes which may undermine the finance and organization of the Church itself must be cast aside.

Rejection of the Nazi materialistic conception of society and insistence upon the dignity of human life and the right of all persons, whatever their class, creed or colour, to contribute to the development of our common civilization, which follows from the basic Christian doctrine of the brotherhood of all peoples, will, however, make demands on us all, not merely on our leaders. The call for self-sacrifice may well be greater and will certainly be no less when the War ends than it is to-day. The establishment of social justice calls for endeavour at least as strenuous and whole-hearted as that now demanded to win the War, and it is only in a democratic way of life that the Christian conception of brotherhood can find full expression in our national life.

The precise form of our democracy may be a matter for experts rather than for individual Christians as such to determine and there can be only confusion if the Church through its leaders or through individuals attempts to pronounce on technical details. The difficulty in drawing the line is of course one of the major problems in such a movement as that which was launched by the Albert Hall meeting, but beyond the broad principles which should be included in a democratic society the Church has a right to indicate immediate and practical objectives in the field of social and economic justice. Moreover, it is its duty to test the proposals which may be advanced by others and to examine how far they serve the principles declared and are in harmony with the spirit and ideals for which the Church stands.

These practical objectives should, as Sir Stafford Cripps pointed out, at least include the five simple desires desiderated by President Roosevelt in his speech to Congress last year when he enumerated the four freedoms. Equality of opportunity for youth and others; jobs for those who work; security for those who need it; the ending of privilege for the few and the preservation of civil liberties for all—these are based upon elementary principles of Christian justice but their attainment makes personal demands on all. Great changes in the planning and organization of production may be involved in the provision of jobs for all. The ending of privilege requires the surrender of our own privileges with the rest, not excluding that of endowment and establishment for the Church. Equality of opportunity for youth means that our children must share a common system of education with those of all others, and if security is to be given to all who need it, the sacrifice of many non-essentials by us may be required to provide with certainty the essentials that others require.

In this task the place of education is fundamental. The mistakes in making the peace after the War of 1914–18 may be repeated unless men and women are educated as to the sacrifice and effort that will be required of them and not merely of others even to establish the four freedoms and serve such simple basic needs. Moreover, men and women will not fully answer that call to self-sacrifice and service unless they understand with their minds something of what is demanded of them. The new vision must be seen in the schools and the new values learnt there as well as proclaimed by the Church if we are to see a new and nobler order of society in which our democratic institutions are renewed and revived by the ideals and ethics of Christianity.

There is therefore every reason to welcome this demonstration that the Church recognizes the challenge of the age and is accepting the responsibilities which are hers in this task of reconstructing society. There can be no misunderstanding of the difficulty of the task of convincing the world that no private or selfish interest should be allowed to thwart the full application of the principles in which we believe. Courage and example as well as precept and steady, untiring pressure will be required for success in this warfare also; and there are the further difficulties inherent in the appeal to moral and spiritual values where terms are ill-defined and easily misunderstood.

The task is, however, one for action as well as for lucid thinking. It is the old problem which scientific workers have reason to know too well of the relating of knowledge to action. Even the calm, serious spirit of science with its tireless quest for truth, while it can give men the knowledge they require to build a new world, cannot supply either the wisdom or the driving force to ensure that that knowledge is used aright. We need the inspiration which comes from a quickened sense of the enduring human and spiritual values in man's great heritage now imperilled by the paganism and barbarism which has broken out in Europe and in Asia alike. Neither the Archbishops nor Sir Stafford Cripps would claim that all those values are derived from Christianity alone, though they might well claim that in Christianity we have learnt to give them a fuller and less academic meaning. At least we may hope that the campaign thus launched may give men and women a new sense of the enduring values of life out of which may spring a firmness of purpose, a vision and judgment which will inspire alike the wisdom needed to guide our use of knowledge and resources and the courage and self-sacrifice required to fulfil all our hopes of a new order of the world, which will not merely be recompense for the present sufferings but also be worthy of the best in our moral and spiritual heritage.

POLITICS AS A PROFESSION

Return to Reason!

An Essay in Political Diagnosis. By Geoffrey Bourne. (Hutchinson's Booklover's Library.) Pp. 64. (London, New York and Melbourne: Hutchinson and Co. (Publishers), Ltd., 1942.) 2*s.* 6*d.* net.

WHETHER we like it or not a new order is coming. By this I do not mean the curious political philosophy paraded under that name but the changes brought about by the strong acid solvent of a great war. The Napoleonic wars spread throughout Europe the principles of the French Revolution; Alexander left Greek culture behind in India. The very violence of this present conflict will eat away the dry rot of many an old privilege and outworn allegiance. Mankind learns quicker to-day; the higher intelligence quotient of the average man gives a better spring-board for the start off. While admittedly the human animal would seem slow at its lessons it is not altogether a dullard, and war, as I have said, acts as a powerful tonic.

Among the many aspects of human life awaiting overhaul, an important one is the system of government. Problems of this nature resolve themselves fundamentally into the relations between public interest and private right; they are concerned less with the individual as such than with his place as a social unit. And the old order changeth; frictions that were at the best tolerable before have taken on a fresh keenness, a new and sharper edge, from the rise in mere bulk of population, the swarming multitude pressing outward with a swelling intensity to a place in the sun. There are, of course, other angles to the situation but it is the swift rise in numbers alone that adds a strident urgency.

Agreement has been very generally come to on democracy as the most satisfactory system. Plato said something about it when the great centres of civilization were a few Greek villages. Recent thought, such as Ernest Barker's notable contribution, does but give the same principles a greater detail. But a democratic government, while it does mean majority rule, while it does concede certain formulæ of social contact, has to obtain specific form, has to be deputed into administrative, legislative and judicial expression. The mob in Athens might frequently enjoy debate, the mob in England can only go to the hustings on a rare occasion.

Here in Great Britain circumstances, historical and geographical, have led to the development of a political structure, offering in the past a satisfactory adaptation to the needs of our social life. The two-party system which is an accepted part has been found reasonable in theory and convenient in practice; it has allowed for much that is flexible and plastic in detail upon a framework that is rigid and defined.

But the anachronisms, the inequalities, the stupidities, the creaking of the joints so audible at every step that were well enough for England in Tudor, in Hanoverian or even in Victorian days, are no longer admissible to-day. The man in the street, the common man, you and I, everyone of us, wants and wants here and now, the same competence and efficiency in government that we see in every department store or railway company. The difficulty is how to do it, how to improve upon existing arrangements, not abruptly or violently but sanely and soberly, commensurate with the reasonable needs of forty million people.

This is the problem which has been taken up by Dr. Geoffrey Bourne in "Return to Reason". The author is a medical man; he specializes in cardiology and is on the staff of one of the great teaching hospitals in London. In his own line he holds a distinguished position, one of an eminence shared by very few in England. He is thus able to bring to a subject, admittedly foreign to his own but one of serious import to everyone, a trained and disciplined intelligence. More than that, an attitude of mind accustomed to weigh and consider the interplay of circumstance and to seek at all times a balanced and considered judgment.

"Return to Reason" is a remarkable book. It offers an ordered study of the political situation in England to-day and submits a thesis of modifications practicable at an early moment and reasonable in design and detail. It is radical but not revolutionary. The writer allows his brush a bold sweep; he would certainly agree that people get the Government they deserve, for it is on this basis that he builds up his argument. He does not seek to apportion petty blame but explains how the choice of the ordinary man deriving rather from the heart than the head must have certain logical results.

This breadth of approach to a very large subject necessarily restricts the attack in depth but it is obvious that this has been so intended. He has deliberately sought to reach the notice and hold the attention of everyone capable of consecutive thought above matriculation standard, a width of appeal demanded by the importance of his subject and its very general concern. The book is free from the polemics of the tub-thumper and from meretricious argument slurring over faulty premisses. It is, in short, an attempt to approach politics from the point of view of the adult man who asks nothing more than the Government he would give himself. It is on some such basis, not necessarily of detail but of the underlying attitude of "Return to Reason", that we can and should take up the responsibilities of a better arrangement of our social life.

Dr. Bourne believes in democracy but qualifies his belief by reminding us that "democracy is not an easy form of government". He points out that the serious use of the function of intelligence on the part of the governed is essential if participation in the actualities of government is to be a reality and not an agreeable fiction. The author, therefore, to develop his subject logically, devotes his earlier chapters to explaining how easily man is swayed by his emotions, how powerful they are, how difficult it is for anyone to remain detached, cool and sane in a welter of conflicting ideologies and breathing constantly an atmosphere tainted with thalamic urges. It is so much easier at the end of a heavy day to swallow wholesale the glib propaganda of the electioneering agent. It is so much easier to be Conservative with a capital C than to bother thinking out seriously national concerns. Dr. Bourne takes pains to indicate, in the structure of the human mind, the strength, the vehemence, the overwhelming intensity of the mass of crude emotions that rule the ordinary man. But he submits that, be that as it may, man has shown the capacity of sustained thought, the inclination to recognize his primitive side as irrational and impulsive and the desire to subordinate it to the control of his intelligence.

Guidance on these lines may be found in the analogy of the professions. In them, all of them, the dominant note in their educational scheme is the development of an attitude of mind giving a true value to reason, to literal fact and to logical argument. That so many men can and do live lives consistently governed by such a code, that they can find themselves rising above the bonds of time and circumstance, of personal welfare, of national differences, into an atmosphere where all can meet in easy fellowship on a plane of a consuming unity of interest over-riding all other considerations whatever as in the scientific world, holds out the promise of what man will yet become.

Dr. Bourne goes still a further step; he not only accepts democracy, he also thinks the British system a workable one. He is, in short, intent on being practical, he would make bricks with the straw we have. He points out the flaws in the system as it is at present practised. These we all know. Influenced and rightly so by on one hand the pressing need for serious, sober, scientific consideration of many social difficulties, and on the other hand by the system of training that has proved such a stimulus to the practice of medicine, he submits that the practice of politics would be materially improved by being turned into a profession. By this he by no means refers to the professional politician of to-day who is only the equivalent of the quack in medicine, but suggests that a similar standard of educational attainments in the many branches of knowledge advantageous in politics could be arranged and that it would be likely to produce the type of man who would on one hand represent adequately the electorate and on the other hand be capable of debating or discussing the manifold complexities of government. A professional standard, certain recognized qualifications, are rightly expected from a teacher, a dentist, a barrister or an accountant; the principle has been particularly successful in these instances, in the sense that it has brought proper service where it was needed, that it has been to the public interest, and that it has tended to heighten in the members of these professions both the moral sense of honourable duty and the scientific search for truth.

Dr. Bourne would like to see the practice of politics subjected to the same educative influences, the same increasingly exact standards that have raised and dignified the other professions in England. The central idea is sound, there are many obvious points in its favour, and the arguments with which he buttresses his case are carefully set out, logical in arrangement and appealing in conclusion.

"Return to Reason" is a competent and careful contribution to current political thought. It indicates a step in electoral procedure, advantageous in every way to the interest of the intelligent voter. Some such change is clearly imminent; a solution on these lines would at any rate give more flesh and bone to a system involving the apparent inconsistency of ruling by the ruled.

JOSEPH GEOGHEGAN.

THE STUDY OF DECAPOD LARVÆ

Larvæ of Decapod Crustacea

By Dr. Robert Gurney. Pp. viii+306. (Ray Society Volume, No. 129, for the year 1941.) (London: Bernard Quaritch, Ltd., 1942.) 25s.

LITTLE more than a century ago Vaughan Thompson showed that a decapod crustacean leaves the egg in a form very different from its parent—a discovery received with incredulity by many well-known zoologists. The fact once accepted, developmental studies have steadily progressed. Claus stands out in his comparative work and, later, G. O. Sars laid the foundation of accurate knowledge of larval stages. In those days there were no facilities for rearing larvæ and the stages were picked out of the plankton and the life-histories pieced together from live or, more often, preserved material. Expeditions, from the "Challenger" onwards, brought back unknown larvæ, often from deep water, and these were frequently described as distinct genera. The collections, necessarily always preserved, contained many imperfect specimens.

With modern research and marine laboratories a very different state of affairs offers itself, and the specialist can collect his own material alive and keep it alive over periods of moulting; or hatch the larva from the egg. Gurney's work is of this kind. He has described larvæ from all over the world, giving special attention to the British species at Plymouth and to those from the Red Sea and Bermuda. This intensive work on the live animals has resulted in a large addition to our knowledge. In 1924 he published in the "Terra Nova" Reports a general account of the decapod larvæ, for the first time bringing all together and summarizing the subject. This was followed by the valuable series of monographs in the "Discovery" Reports, and many papers were published in various journals. With such experience based on so much field work this book should be, and is, full of new ideas. A glance at the systematic portion shows how much we have progressed since 1924.

Of importance is the placing of the Euphausiacea definitely in the Decapoda. It has gradually come to be accepted that the two groups are nearly related, the resemblance between the Euphausiacea and the Penæidea being remarkably close, both retaining many characters regarded as primitive. In discussing the larval stages the view is held, and with good reason, that stages 1 to 3 of the normal Caridean development represent the three protozoeal stages of Penæidea and the three Calyptopis stages of the Euphausiacea. Also that the stage passed through in the egg and sometimes surviving into free life in the form of the embryonic cuticle represents the nauplius and not the protozoea.

It is emphasized that the fundamental fact which determines the organization of the larva is the division of the stages according to their method of swimming. In the nauplius the main organ of locomotion is the antenna as in the primitive Branchiopod, and in the protozoea of the Euphausiacea and the Penæidea it still has that functional importance. In the decapod larva later than the nauplius and protozoea, thoracic locomotion replaces it; in the moult to post-larva, abdominal propulsion takes its place. Thus decapod development is regarded as made up of four phases of phylogenetic significance: nauplius and protozoea with antennal, zoea with thoracic, and post-larval with abdominal propulsion.

New light is thrown on the much-discussed question of giant larvæ. Gurney's recent work on Procletes has proved that it is the larva of Heterocarpus. If this, the largest decapod known, can be accounted for, it is probable that most of the other out-size larvæ will turn out to be ordinary larval stages of known or unknown genera. Nevertheless, it is shown that many larvæ, especially those from deep water, may continue to moult, as larvæ, much beyond the time of normal metamorphosis, and in the sense that they failed to metamorphose at the proper moment, but have continued to moult, may be regarded as abnormal.

Whenever and wherever detailed work is done on decapod larvæ, it is found that there are many more species than there are adults to fit them. This means that there are many undiscovered adults. Lurking in habitats difficult of access, there must be many unknown forms. It is often by means of the larvæ that new adults are discovered, which proves that there is some importance in larval characters as a help in making natural classifications. There is no undue optimism in the present work as to the value of the larva in systematics, according to our knowledge up to date, although it is shown that in some groups the larvæ point to drastic changes. This is specially the case in the Oxystomata, which cries aloud for revision. The conclusion is reached that "the evidence from development so far accumulated has not produced any very serious contribution to the systematics of the group". In spite of this statement, the systematic portion of the book shows that we can usually place a larva more or less accurately in its proper position, although there are still many mysterious forms. The answer to it is that we do not yet know enough and that we must go on working, and we look forward to the time when all systematic work will include both larva and adult, and a truly natural classification will result.

Apart from the number of biological problems which arise from the study of decapod larvæ and their systematic interest, they are of much importance economically. For the fisheries investigator a detailed knowledge of the life-histories of all those of food value is essential; for the oceanographer the study of currents is materially helped by their accurate determination. The book bristles with problems. It is indispensable to all specialists on the subject, to the general zoologist and to the student.

The illustrations, in pure outline, are exactly suitable to the subject. With the exception of one or two, they are all original and have not been published before. The form of the volume is in every way as good as usual, and the Ray Society is to be congratulated on the production of such a volume in these difficult times. The companion volume by Gurney, "A Bibliography of Decapod Larvæ", was published by the Ray Society in 1939.

THE HUMANITIES OF CHEMISTRY

Collateral Readings in Inorganic Chemistry

Second Series. Edited by L. A. Goldblatt. Pp. viii+198. (New York and London: D. Appleton-Century Co., Inc., 1942.) n.p.

In a rapidly changing world the whole system of education must come under review and the teaching of science cannot escape. The ideal surely is a cultural background as full as possible and a training which produces a graduate able to think both critically and constructively, with a wide knowledge of his subject. A student who has devoted his energies mainly to the memorizing of facts, largely for the purpose of passing examinations, and is in truth little more than an encyclopædia bound in skin with all the inaccuracies of such treatises, is likely to disappoint both himself and his employers when he goes out into the world.

The problem is how to teach the mass of facts which constitute a science and at the same time show the student that the subject is real and human, even exciting when viewed from a little distance, far enough to forget the menace of an examination. Fifty years ago, when there was less to master, there was much more time for original reading. Most of us then read all we could lay our hands on, both the current journals and the classic papers of the past. They were longer but far more colourful, especially when polemic. We read about subjects remote from our own particular researches, and the chemical world was made real to us, a pleasure not a task.

This is admittedly impossible to-day, the literature is so large; moreover, the need for condensation makes most papers unreadable except by experts in the particular field. How is the student to gain an idea of the broader implications and humanities of his subject?

One answer is provided by the "Collateral Readings" edited by Mr. Goldblatt. He has reprinted and collected under one cover some thirty-six articles in inorganic chemistry by many of the leaders in the United States each of which is essentially stimulating, even exciting, and can be classed as leisure reading and not work. The first article is Bogert's "From the Cradle to the Grave", one of the best expositions of what applied chemistry is doing and can do ever written; the others cover specific industrial subjects such as bromine or magnesium from the sea, argon, radium, phosphorus, sulphur; more theoretical subjects such as atomic weights, the periodic system, electrolytes, the polar molecule concept; or general questions like text-books and abstracts. The whole volume has a definite commercial flavour, for American chemists expect to enter industry and make their contribution to the world's progress in industrial research laboratories. They are unaware that this is still regarded in England as not quite the thing.

Taken as a whole, the articles are well selected and make first-class reading: there can be few chemists in Great Britain who would not gain from reading them. Any student who really intends his chemical studies to be serious would be bound to benefit from them and should find them far more exciting than any crime novel, of which there are so surprisingly many on both sides of the Atlantic.

E. F. Armstrong.

A NEW SOCIAL SURVEY

Nutrition and Size of Family

Report on a New Housing Estate, 1939. Prepared for the Birmingham Social Survey Committee by M. S. Soutar, Dr. E. H. Wilkins and Dr. P. Sargant Florence. Pp. 50. (London: George Allen and Unwin, Ltd., 1942.) 2*s*. 6*d*. net.

The social, economic and environmental changes produced by the War have not so far invalidated the major findings of pre-war social surveys. The social statistics made available by the investigations at York, Bristol, Merseyside, Tyneside and other inquiries will be of value to those concerned with reconstruction. To the existing corpus of knowledge we now have to add an excellent little report prepared by the Birmingham Social Survey Committee. This report breaks new ground. Not only did the Survey set out to ascertain the extent of poverty in families of different sizes (only families with children were studied), but also it attempted to find out the adequacy of income as measured by the amount of housekeeping money in the hands of the housewife. The adoption of this realistic approach showed a startling increase of poverty with increasing family size. Thus the proportion in each group below sufficiency were: with one child 13 per cent, with two children 45 per cent, with three 65 per cent, with four 85 per cent, with five 96 per cent and with six or more 96 per cent. This method revealed that *actual* poverty is much greater than is disclosed by the type of measurement hitherto adopted in social survey work.

This study, which relates to a new housing estate outside Birmingham, was carried out in mid-1939—a period of relative prosperity. In addition to its many interesting findings, the Survey shows that bread consumption rose after rehousing. Town planners should note that, as an independent social reform, rehousing has its limitations.

POTATO VIRUS DISEASES

By F. C. BAWDEN

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THE degeneration of the potato seems to have been unknown in Europe before about 1770, but after that it rapidly assumed such proportions that by 1780 farmers in some districts had to abandon potato growing, and prizes were offered to those who could find the cause and devise a cure for this serious affliction of so important a crop. For 150 years there was continual speculation and controversy about the cause of this degeneration. Some shrewd observers drew deductions that recent work has fully confirmed, but in the absence of any direct experimental evidence the most widely held view was that potatoes degenerate because they are weakened by continual propagation by 'unnatural' asexual methods. Only within the last twenty years has it become clear that degeneration is a result of plants becoming infected with one or more viruses, which are handed on to the progeny through tubers, but rarely, if ever, through the true seeds. If one can judge from the size of the audience at a discussion on this subject, arranged jointly by the Association of Applied Biologists and the British Mycological Society*, on October 9, this advance in our knowledge has certainly not lessened interest in the problem.

Many early writers noticed that potatoes degenerated more rapidly in some districts than in others, and a few suggested that there was some correlation between degeneration and infestation with aphids. Long before virus diseases were recognized, some growers in the south and east of Great Britain regularly obtained new supplies of seed from the north and west, and in this way avoided serious losses. With the discovery that the most destructive virus diseases are transmitted by aphids, and that the weather in the north and west usually inhibits the multiplication and movement of aphids, this method of control has been increased enormously. Steps have also been taken to improve on the natural advantages of these districts. The crops are examined periodically and diseased plants removed; they are also inspected and awarded certificates of health stating that they contain less than a small percentage of infected plants. Mr. G. Samuel stated that at the present time something more than 300,000 tons of such certified seed is imported into England from Scotland and Ireland each year. Within two or three years this has become valueless for seed purposes, and he described this wastage as our most important plant pathological problem.

Some twenty viruses that affect the potato have now been described, but in Great Britain most of the losses are caused by three: leaf roll, potato *Y* and potato *X*. These differ strikingly from one another in their behaviour, and Mr. F. C. Bawden showed that conditions favouring the spread of one might not favour the spread of another. Even with viruses transmitted by aphids this is true, for the relationships between different viruses and their vectors differ. For example, aphids become infective with leaf roll only slowly; a day or so must elapse after they have fed on a diseased plant before they can infect a healthy one, but once they have become infective they go on being so for the remainder of their lives. Mrs. M. A. Watson has shown that the position with potato virus *Y* is very different. Aphids can transmit this virus immediately after feeding on a diseased plant, and, oddly enough, they transmit more readily if they are first starved and then fed for only a few minutes on a diseased plant. Such aphids also remain infective for only short periods, sometimes minutes and never more than hours. These differences offer an interpretation of the fact that, with crops in which both viruses are present, one may spread considerably while the other does not. For the slow-moving, wingless aphids would seem ideally suitable for spreading leaf-roll, whereas the winged migrants are much more likely to fulfil the requirements for transmission of potato virus *Y*.

Scotch and Irish stocks owe their superiority to their relative freedom from these two aphid-transmitted viruses, for even the best of these stocks are often infected with virus *X*. In many varieties this produces a mild mottling of the leaves, insufficient to be noticed readily, especially if all the plants are uniformly affected. In spite of the slight leaf symptoms, various workers have found that such infections can reduce the yield by 20 per cent; this is small compared with the 50–90 per cent reduction found for different varieties with leaf-roll and severe mosaic, but is nevertheless considerable. There is, therefore, still room for improvement in our certified stocks. The method being tried is to test individual plants of established varieties until some are found free from this virus and then multiply these as nuclear stocks to replace those now grown. Some of the difficulties of this method were described by Dr. Kenneth M. Smith. With many of our commercial varieties it has so far proved impossible to find a single plant uninfected. But even when this first difficulty is overcome, the problem is by no means simple. We know no insect vectors for this virus, and we are still largely ignorant of what precautions to take to keep such plants healthy. Workers in Ireland find that healthy plants can become infected if their leaves rub against infected plants, but there is some doubt if this method of spread could account for all infections. Virus *X* is found in crops other than potatoes, both under glass and in the field, and healthy potatoes in insect-proofed glasshouses are not always safe against it. It is obvious that the multiplication of stocks free from this virus is important; but before it can be embarked upon on a large scale further research is needed on the conditions that lead to infection.

Although Scotland and Ireland produce most of our best potato seed, they have no monopoly. On the wind-swept hills of Wales, Cumberland and Devon and Cornwall aphids are also rare, and in these districts there are now flourishing associations for the production of certified seed. The oldest of these is in North Wales, where for fifteen years Dr. T. Whitehead has maintained the same stocks in a state of vigour. Over this period he demonstrated a close correlation between aphid numbers and the health of the stocks, and only in a few exceptional years in which aphids have multiplied excessively has there been any difficulty in keeping the health of stocks up to the standards for certification. The most important aphid is *Myzus persicæ*. Its normal method of overwintering is in the egg stage on peach trees; but it can also survive in the adult form under glass and, in favourable conditions, in the open on cruciferous crops, especially savoys. In North Wales, where there are few peach trees, Dr. I. Thomas considers that the degree of infestation of the potato crop is largely determined by the severity of the—

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* It is hoped that the proceedings will be published in full in the February number of the *Annals of Applied Biology*.

previous winter, for only when conditions favour overwintering out of doors are the numbers of aphids large. The importance of the method of overwintering is also shown by *Aphis rhamni*, which in this region is found in numbers only in the few localities where the winter host *Rhamnus catharticus* occurs.

In East Anglia conditions are very different. Mr. J. P. Doncaster finds that *A. rhamni* is the commonest aphid on potatoes, and frequently reaches an average of more than a hundred per leaf. Fortunately, this aphid does not seem to transmit leaf roll. As it moves about less readily than *Myzus persicæ*, it is probably less important as a vector, but it is likely that the migratory forms play a considerable part in the transmission of potato virus *Y*. Overwintering on Brassicæ seems to be rare in East Anglia, but here there are sufficient peach trees and glasshouses to provide ample sources for *M. persicæ* in the spring. No attempts have yet been made to control the aphids by treating their overwintering sources, for example, by wholesale winter-washing of trees and fumigation of glasshouses; but Mr. Doncaster reported that on the potato crop a complete kill was obtained by fumigation with nicotine. The effects of the treatment, however, were only temporary, and the fumigated crop rapidly became re-infested from nearby sources not treated.

After examining many potato crops in eastern England, Dr. P. H. Gregory and Mr. Doncaster could find no simple correlation between numbers of aphids and amount of spread of leaf roll and potato virus *Y*. It seems likely that in these districts there are almost always sufficient aphids for rapid spread and that whether this occurs or not depends on other factors, probably those influencing the movement of the insects. In many crops in 1941 there was a striking difference between the behaviour of the two aphid-transmitted viruses. Potato virus *Y* spread only to a small extent and only early in the season, again suggesting a correlation between the winged migrants and spread of this virus. By contrast, the number of plants infected with leaf roll virus increased steadily throughout the season, and in some stocks with large haulms, in which movement of crawling aphids from plant to plant would be facilitated, the percentage of infected plants increased more than twenty times.

The ability of one and the same potato virus to produce different symptoms in different potato varieties greatly complicates diagnosis, but can also be of value in helping to reduce losses. Paradoxically, it is the most susceptible varieties that suffer least. Some British varieties, for example, King Edward and Epicure, die quickly when infected with virus *X*. Infected plants leave no viable tubers to act as further sources of infection, and the stock as a whole is safeguarded by the death of the individual. Similarly, other varieties are killed by infection with viruses *A*, *B* and *C*. In effect, such varieties do their own roguing, and Dr. G. Cockerham showed that the health of commercial stocks of these varieties is much better than that of those which tolerate infection. This hypersensitivity is inherited, and by crossing between different varieties, the Scottish Society for Research in Plant Breeding has produced Craig's Defiance, which dies when infected with any of viruses *A*, *B*, *C* and *X*, so that stocks of this variety remain virtually free from all four. Unfortunately, no varieties are known which are hypersensitive to leaf roll and virus *Y*, but after testing some hundreds of different varieties Dr. Cockerham reported that he had found some with a true resistance. As this is also inherited, it seems that the geneticist will begin to play an increasingly important part in combating potato virus diseases. However, no quick success can be expected by this method; also, viruses appear to mutate with such frequency that permanent success should not be expected either, as it is impossible to be sure for how long a new variety bred for some specific property will retain this in the field.

In an attempt to increase the health of crops from once-grown seed, the Ministry of Agriculture has since the War introduced a scheme whereby crops in England, grown from Scotch or Irish seed and planted fifty yards from other potatoes, receive a seed certificate. Mr. Samuel showed that the measure is meeting with some success, for such seed usually contains less than 10 per cent of severely affected plants and crops as well as new seed, but it does not greatly increase the useful life of the stock. One wonders whether the information we now have about potato virus diseases could not be still further applied. In normal times it may be that the import of new seed each year is the most economical control measure, but now the transport of 300,000 tons of potatoes is in itself a problem. In many parts of England it is likely that the growing of heavy crops of ware potatoes and the production of good seed are incompatible, for maximum yield is obtained only if the plants have a long growing period and this greatly increases the likelihood of infection. But crops grown especially for seed purposes could probably be kept in a good state of health for several years. These could be grown in isolation, possibly on some of the reclaimed land that cannot be expected to yield large crops, rogued, perhaps sprayed or fumigated against aphids, and the tops killed early in August, after all the tubers are formed but before virus diseases have had time to spread appreciably. The contributions at the discussion all suggested that this may be a practical control measure, but it urgently needs testing on a commercial scale.

VELOCITY OF RADIO-FREQUENCY WAVES*

By Dr. R. L. SMITH-ROSE
National Physical Laboratory

THE wireless engineer and radio physicist require to know the speed or velocity of electric waves in order, for example, to convert their measurements of frequency into the corresponding wave-lengths, while various methods of studying the propagation and direction of arrival of waves involve a knowledge of the wave velocity.

Apart from the various classical experiments on the velocity of light conducted during the latter half of the nineteenth century, the most comprehensive work on this subject was carried out by Prof. Michelson and his co-workers, and the most important part of these investigations were in progress when Michelson died in 1931. The equipment used in this work is notable by reason of the fact that the path traversed by the light waves was enclosed in a steel tube one mile long and three feet in diameter, this tube being evacuated to a pressure of a few millimetres of mercury. By multiple reflexions between mirrors set up in this tube, the light waves were caused to traverse a total path-length of some 8–10 miles in a vacuum before and after reflexion from a thirty-two-faced rotating mirror used to determine the time of travel of the waves over this path.

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* Substance of the chairman's address before the Wireless Section of the Institution of Electrical Engineers, delivered on Oct. 7.

The development of radio-frequency technique has facilitated the measurement of the velocity of light on a laboratory scale by a method which has been used by W. C. Anderson and others. In this, the light waves are modulated at a radio-frequency of from 20 to 100 megacycles per cycle by their passage through a Kerr cell subjected to an alternating voltage at this frequency. Two portions of this modulated light beam are made to traverse paths differing in length by some 10–20 metres before being received on a photo-electric cell equipment used to measure the resulting intensity of the light received.

A summary of the most accurate measurements carried out by these two methods is given in the following table:

RECENT MEASUREMENTS OF THE VELOCITY OF LIGHT

Values refer to transmission in a vacuum

Date	Observers	Velocity in cm. per sec. $\times 10^{-10}$	Accuracy of measurement	Difference from $c = 3 \times 10^{10}$
1931–33	Michelson, Pease and Pearson	2·99774	0·4 in 10^4	$-7·5$ in 10^4
1936–40	Anderson	2·99776	0·5 in 10^4	$-7·5$ in 10^4

Since for radio purposes we are rarely concerned with wave transmission in a vacuum, the above values will require to be multiplied by $1/\sqrt{\kappa}$ where κ is the dielectric constant of the medium in question. For air under normal atmospheric conditions at the earth's surface in Great Britain, corresponding to a pressure of 760 mm. mercury, temperature of 15° C. and a relative humidity of 70 per cent, the value of κ is about 1·0007, and thus the corresponding value of the velocity will be reduced to $2·99670 \times 10^{10}$ cm. per second.

Our knowledge of the speed at which waves in the radio-frequency spectrum travel is much more limited and less precise. Until about 1935, most investigators in this field used methods which were not free from sources of error arising either from defects in the apparatus or from an insufficient knowledge of the actual path followed by the waves. More recently, some workers have used methods involving the setting up of standing waves in air or on wires, and compared the wave-length so obtained with the frequency of the oscillations given by the source. In 1937, W. Ross and E. C. Slow, of the Radio Department of the National Physical Laboratory, made a determination of the phase velocity of radio waves transmitted along the surface of the ground, using apparatus already developed and in use for other investigations. The average result obtained for this velocity over the wave-length range 20–120 metres (2·5–15 Mc./s.) was $2·95 \times 10^{10}$ cm./sec., the overall experimental accuracy of the measurements being considered to be about 5 per cent.

A most comprehensive investigation of the velocity of medium radio waves (wave-lengths 230–345 m.) was carried out during the years 1934–35 by a group of workers in the laboratories of the U.S.S.R. under the direction of Profs. L. Mandelstam and N. Papalexi; and the details and results of these investigations were published in a collection of papers in *Technical Physics of the U.S.S.R.* in 1937. The method employed comprises a determination of the time of transit of waves between a sending and reflecting station by measuring the phase difference between the two sets of waves, the ratio of the frequencies of which is rational. The subsidiary investigations included the development of methods and instruments for measuring the phase difference between harmonic oscillations of different frequencies, and the study of the phase displacement introduced by high-frequency amplifiers. The accuracy of the measurements depends essentially on the measurement of the two quantities, the phase displacement, and the length of path traversed by the waves between the stations. The total phase displacement used during the observations ranged from a few hundred to several thousand degrees, and the investigators were able to measure these to within 3° or 4°; so that the accuracy of phase measurement was of the order of one or two parts in a thousand in the most favourable cases. The distance measurements were carried out by standard geodetic survey methods, and appear in the most favourable cases to have been determined to an accuracy somewhat better than one part in a thousand (0·1 per cent).

The mean results obtained in the various sets of experiments for the velocity of the medium radio waves used all lie within the limits of 2·990 and $2·995 \times 10^{10}$ cm./sec. for transmission over a clear air path, or over sea or fresh water. As these limits are within the accuracy of the measurements, no definite conclusions can be drawn as to the effect of a salt- or freshwater path on the velocity of propagation. In the case of transmission overland, a somewhat lower value of $2·950 \times 10^{10}$ cm./sec. was obtained, although this would appear to be subject to some uncertainty in determining the true path of transmission, due to various intervening obstacles.

Thus it is found that for the radio-frequency portion of the spectrum, the methods so far used for the determination of the velocity are much less accurate than those used for the velocity of light; and it may be stated that within the limits of the experimental accuracy so far attained, which is not better than 0·1 per cent, the velocity of propagation of medium radio waves is about $2·990 \times 10^{10}$ cm./sec. The experimental evidence so far available indicates that this value for the velocity is the same for all radio wave-lengths within the accuracy specified above. There is some evidence that the phase velocity may be reduced below this value near the transmitting aerial, and it may also be modified when transmission takes place close to the surface of the earth; but it seems doubtful if this variation from the free space value amounts to more than the experimental accuracy, except where obstacles such as trees and mountains intervene in the path of propagation. In this case it is not necessarily the velocity which has altered, but rather that the path traversed has been increased.

This discussion of our present knowledge leaves the problem of the measurement or calculation of the actual time of transit of radio waves between sender and receiver still open to investigation. This type of information may be required for a number of purposes, such as the use of time signals for the comparison of chronological standards and for the determination of differences of longitude. For the solution of this problem, a knowledge of the free space speed is only one requirement: it still needs a precise specification of the actual path, rectilinear or otherwise, followed by the waves, and of any modification to the velocity value produced by atmospheric or ionospheric conditions.

MICROBIAL FACTORS IN THE DIGESTIVE ASSIMILATION OF STARCH AND CELLULOSE IN HERBIVORA

By FRANK BAKER
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MICROBIAL processes are directly concerned in the digestive assimilation by Herbivora of the starch and crude fibre components of their diet. In ruminants the rumen and in non-ruminants the cæcum is the chief focus of these activities. Great diversity of opinion, however, exists in regard to the type or types of micro-organisms primarily responsible for the changes taking place[1,2]. This confusion must in large measure be attributed to the application of methods inappropriate to the resolution of the problem; and in particular to the exclusive and premature reliance placed on pure cultural technique. For, first, it is impossible by plating out to distinguish with certainty between the casual passengers through and the permanent inhabitants of the gastro-intestinal tract. Secondly, the majority of micro-organisms indigenous to the cæcum and rumen are not susceptible of cultivation on any of the media ordinarily employed.

I have shown, however, that these difficulties can be circumvented by the use of methods of direct microscopical observation[3]. It must be emphasized that these methods are not confined to a mere academic enumeration of species. By examination in polarized light[3,4,5,6] the disintegration of cellulosic structures can be studied in detail from start to finish in material freshly withdrawn from the rumen or cæcum. The changes taking place can be still further elucidated by histochemical and staining procedures[4,5,7]. Similar methods can be applied to the study of starch granules in process of disintegration. Thus the functional activities as well as the morphological characteristics of the micro-organisms present may be ascertained. The results obtained can be recorded by photomicrographs. Nor, again, is the method of direct microscopical observation limited to qualitative data. Ferber long ago showed that the influence of dietetic factors on the rate of multiplication of the rumen Protozoa could be studied by the use of counting methods[8,1]. In collaboration with the Hannah Dairy Research Institute I have since found that similar methods can be extended to the iodophile microflora of the rumen and cæcum. Lastly, it may be noted that the method may be applied to formalized samples, so that material may be preserved *in vitro* for an indefinite period. This makes it possible to check or amplify observations over the entire course of a lengthy investigation. Similarly, by the use of coded samples, the objectivity of the data obtained by counting methods can be placed beyond question and subjective influences eliminated.

It is clear, therefore, that by the systematic assemblage and examination of appropriate collections of material a whole field of research is opened up which lies altogether beyond the range of pure cultural methods of investigation. These possibilities will, however, only be realized to the full when the method of direct microscopic examination has been adopted as a routine procedure by a sufficient number of observers. Nevertheless, observations accumulated over the course of several years already make it possible to elucidate some of the more conspicuous features which attend the microbial decomposition of starch and cellulose in Herbivora. The purpose of this article is to outline a consistent picture of these features and tentatively to indicate their significance in regard to the digestive process of the host-animals. To this end it is necessary briefly to summarize the general characteristics of the microbial associations established in the rumen or cæcum. These associations include, in addition to a number of species with which we need not here concern ourselves,[4,5,9]:

(*a*) *Iodophile micro-organisms* of taxonomically diverse types such as collectively constitute the *iodophile microflora*[9];

(*b*) Protozoa belonging to a highly specialized order of ciliates, the Entodiniomorpha[11].

Both these groups play a part in the carbohydrate transformations of the gastro-intestinal tract. The distinctive feature of the iodophile micro-organisms is the blue-black reaction which they give with iodine, owing to the deposition within them of a polysaccharide[12], the so-called bacterial starch or granulose. Most of the species encountered are of unusually large dimensions[4,5,7,9,10,13]. They include sarcina[5,13], Diplococcus[7], Streptococcus[4,5,7,9,13], Spirillum[5,13], and Clostridial forms[10], together with sporing and non-sporing rods[7,9,10] and several species of uncertain systematic position[5,13]. In addition, organisms of Oscillarian affinities are encountered in the guinea pig, sheep and cow[9,12,13].

The iodophile microflora becomes established in the rabbit towards the close of milk feeding with the adoption of a vegetable diet[14]. Different constellations of species may be present in different species of Herbivora. Where these differences are marked, as in the case of the guinea pig and rabbit, they may persist even when the animals are fed on the same diet and kept in the same cage. Thus internal as well as external factors determined the characteristics of the microflora.

That certain iodophile species play a determinate role in the decomposition of cellulose can be demonstrated by direct microscopic examination in polarized light[6]. The iodophile micro-organisms are encountered upon the surfaces and within the interstices of the vegetable fragments present. Disintegration is accompanied by excision of enzymatic cavities, the contour of which corresponds precisely with that of the micro-organisms by which they are produced. In the affected regions birefringence ceases and microchemical reactions disappear. Lignified structures partially and cutinized structures entirely resist disintegration. The age, therefore, as well as the botanical species of the plant material fed will affect the amount of cellulose digested[3].

Examination of rumen or cæcal contents demonstrates that iodophile micro-organisms are also directly concerned in the decomposition of starch.

Granules in all stages of disintegration are encountered upon the surfaces of which innumerable iodophile micro-organisms are lodged. Streptococci are the species normally associated with this process in the rumen of the sheep and cow and in the cæcum of the rabbit. In the guinea pig curved iodophile clostridia are the predominating type. Granules undergoing disintegration show a progressive diminution in birefringence. Their originally blue-black is gradually replaced by a reddish reaction to iodine. In non-ruminants, such as the guinea pig, I have observed that the feeding of a diet rich in starch results in a very marked increase in the total iodophile microflora of the cæcum. This increase involves the free-living species as well as those attached to the disintegrating granules. Again, in collaboration with the Hannah Dairy Research Institute, I have established, by counting methods, that the addition of increasing amounts of starch to rumen contents incubated *in vitro* results in a parallel increase in the rate of multiplication of iodophile micro-organisms of all types. These facts demonstrate that the ability to synthesize iodophile polysaccharide is not confined to the particular species directly responsible for disintegration. Similar conclusions may legitimately be extended to the decomposition of cellulose. The view may therefore be advanced that the iodophile microflora not only comprises the particular agents immediately concerned in the disintegration of starch and cellulosic substrates but, in addition, functions as a general acceptor of the soluble products of decomposition liberated[3, 4, 5, 7]. In this way such products are removed from further participation in the reactions taking place and a storage of carbohydrate thereby temporarily effected.

The activities of the iodophile micro-organisms may be supplemented by those of the Entodiniomorpha with which, in some herbivorous species, they are associated. Ciliates of this kind, which are absent from the cæcum of such non-ruminants as the guinea pig and rabbit, are present in enormous numbers in the rumen of most ruminants. Trier[15] long ago demonstrated that they are able to ingest and digest starch grains. Assimilation is accompanied by the deposition of abundant reserves of paraglycogen[15, 16]. In addition to starch, cell-wall residues are ingested. This fact has led some observers to attribute to the ciliates an important role in the digestion of cellulose. Comparisons have been made with the activities of the polymastigotes[17] of lignophagous termites. I have shown that the grounds advanced for these comparisons are not valid[5]. Even, moreover, were the supposed capacity of the rumen Protozoa to digest cellulose demonstrated, it would be of trivial functional significance to the host animal, since the size of the majority of vegetable fragments initially present is such as absolutely to preclude ingestion. But in fact, wherever, as is often the case, ingested particles show signs of disintegration, this can always be referred to the action previously exerted upon them by iodophile micro-organisms. Thus the activities of ciliates are of a subordinate kind in comparison to those of the iodophile microflora, and constitute an orbital fringe to the focus of carbohydrate transformations occurring in the rumen.

In the meantime it will be clear that, irrespective of specific peculiarities, the microbial associations of the herbivora are organized[3, 4, 5, 7] in such a way as directly to secure the accumulation, as products of microbial synthesis, of the substances (other than waste gases) initially liberated in the process of decomposition. The conclusion has therefore been provisionally drawn that it is the substances synthesized, such as microbial protein and polysaccharide, rather than the initial products of decomposition, such as organic acids, that are utilized by the host animal. For this to be possible, it is necessary that at some subsequent period they should be liberated in an assimilable form. In conformance with this requirement is the fact that, in both ruminant and non-ruminant herbivora, an enormous reduction in the iodophile microflora has taken place by the time the food residues have reached the lower regions of the large bowel. I have determined by counting methods that, in the rabbit, this reduction can amount, at a low estimate, to two thirds of the micro-organisms present in the cæcum. The factors concerned in this elimination have been investigated[14] and include:

(1) Ingestion and digestion by ciliates;
(2) Action of digestive enzymes;
(3) Bacterial autolysis.

In the simplest example, elimination may be effected by autolysis alone. This is the case in the rabbit and guinea pig, where Entodiniomorpha are absent and the position of the cæcum precludes an intensive action of digestive enzymes. In ruminants autolysis is reinforced by the activities of the rumen Protozoa. Free-living iodophile micro-organisms, in addition to those adherent to starch grains and vegetable fragments, are taken in and afterwards assimilated. The ciliates in turn are digested in the abomasum. Thus a proportion of the bacterial protein and iodophile polysaccharide present is continuously converted into protozoan protein and paraglycogen. Since it can be demonstrated[14] that the Protozoa are far more readily accessible to the action of digestive enzymes than the iodophile microflora, the possible physiological significance of this conversion cannot be overlooked. In any event it is evident that, in consequence both of the presence of ciliates and of the anatomical relationships of the rumen, not only the process of microbial decomposition and synthesis but also the mechanism of elimination achieves a higher level of organization in ruminant than in non-ruminant Herbivora[3]. This functional differentiation will tend to procure a greater efficiency and an increased latitude of readjustment for the microbial process. To it may in part be due the superior capacity shown by ruminants in the assimilation of crude fibre diet components, and perhaps also their ability to utilize protein substitutes.

In this last connexion it is noteworthy that Westphal was able to maintain the rumen Protozoa for five weeks *in vitro*, in a rumen liquor, by daily addition of small quantities of starch and urea[16]. Ancillary observations show that an iodophile microflora was established in his cultures. In advance of more detailed investigations, the attempt would be premature finally to assess the significance of Westphal's results. Sufficient data have, however, in the meantime been adduced to show that the actual mode of transference to the tissues of the animal of the polysaccharides present in the vegetable materials ingested devolves, *inter alia*, upon the character of the microbial association established in the gastro-intestinal tract. The comparative investigation of such associations, by methods of direct microscopical observation, opens up a hitherto unexplored field for inquiry. By the use of fistular animals the effects of diet upon the microbiological equilibria established can be ascertained. These influences can be still further elucidated by *in vitro* incubations.

Finally, by the enclosure of material in sacs, following the ingenious procedures elaborated by Dr. McAnally at Cambridge[18], it should be possible to investigate the character of the microbial process associated with the decomposition of individual species of food plant. Information assembled in this way, in addition to its theoretical interest, would have a direct practical bearing upon the complex problems which arise in connexion with the effective utilization of particular diets and with the elucidation of an economic feeding practice.

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THE CONDITION OF FRESHLY BURNT GASES

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WHEN inflammable gases are exploded with air or oxygen, the products are frequently observed to luminesce after the passage of the main flame front; the effect is especially marked with explosions in closed vessels, the burnt gases glowing brightly as the pressure waves caused by the explosion travel back through them. In one series of experiments with carbon monoxide, David found that this 'afterburning' could be seen for so long as 14 sec. Observations of this type, and measurements of the temperature distribution following explosions in closed vessels, led Ellis, Wheeler and Morgan to support this afterburning concept. David and colleagues took a series of time-pressure records for explosions of mixtures of dry carbon monoxide and air with small amounts of hydrogen added, using vessels of various dimensions; they found that the ratio of final to initial pressure was greater for explosions in large vessels than in small vessels, from which they concluded that combustion was incomplete in the smaller vessels, and therefore probably still incomplete even in the larger vessels.

Lewis and von Elbe[1] have made a detailed criticism of these conclusions, attributing Ellis, Wheeler and Morgan's observations to necessary results of the temperature and pressure changes taking place following an explosion in a closed vessel, and suggest that David, Brown and El Din's results were caused by pockets of unburnt gases. David has since confirmed the earlier results using explosion vessels of modified design to eliminate any pockets of unburnt gas. Lewis and von Elbe support their conclusion that afterburning is not a real phenomenon by experiments with ozone and with mixtures of hydrogen and oxygen, the maximum pressures attained and the temperature gradients set up agreeing with those expected theoretically.

While the existence of a true afterburning for fuels rich in hydrogen remains in dispute, there can be no doubt from the well-known experiments of the late Prof. W. A. Bone on the marked catalytic action of moisture on the combustion of carbon monoxide that, for very dry gases, explosions are only induced with powerful igniting sparks, and the resulting explosions are of long duration and leave a considerable amount of unburnt gases. Garner and colleagues have studied, qualitatively and quantitatively, the infra-red radiation from explosion flames of carbon monoxide – oxygen mixtures in various states of dryness, and in the presence of certain catalysts. The infra-red radiation is much greater from the carefully dried mixtures, and is considerably reduced by small traces of certain catalysts such as ethyl nitrate or hydrogen. From these experiments, Garner, Hall and Harvey[2] concluded that the carbon dioxide molecules contained initially a considerable excess of vibrational energy, this amounting in some cases to as much as 24 per cent of the heat of combustion.

In addition to the experiments on explosion flames, David has found evidence for the existence of considerable amounts of latent energy in stationary flames, the observed maximum flame temperatures being less than the calculated values. Again, the subject has aroused considerable controversy between Lewis and von Elbe and David, and again it seems difficult to express a final conclusion about the reality of this latent energy for fuels rich in hydrogen, but it is certain that there is a real discrepancy between the observed and calculated temperatures for flames of dry carbon monoxide, this discrepancy being reduced by the addition of a little water or hydrogen to the flame. Measurements of the temperature of dry carbon monoxide – air explosions using thermocouples of bare wire, and of quartz-coated wire, show a very big difference ($\sim$ 300° C.) for weak mixtures, but little difference for mixtures rich in carbon monoxide; this appears to indicate that there is considerable abnormal dissociation of the carbon dioxide molecules in such flames.

Following the observation, by Fowler and Gaydon, of the afterglow of carbon dioxide in a discharge tube, David postulated the existence of carbon dioxide molecules of abnormal structure (electronically activated) to account for his experiments on afterburning and latent energy, and he has recently[3] defended this postulate against the views put forward by Gaydon[4], which attempt to explain the afterburning of carbon monoxide as due to delay in the equipartition of vibrational energy.

From a study of the spectrum of the carbon monoxide flame, Gaydon concluded that the emitter of the spectrum was carbon dioxide, and that emission corresponded to transitions from the electronic state responsible for the weak absorption by carbon dioxide below 1700 A., to the ground state. It has been suggested that the upper state may not be linear as is the ground state of carbon dioxide; this would account for the difference between the regions of absorption and emission for this system, and it would then follow, from the Franck-Condon principle, that in emission transitions would only occur to high vibrational levels of the ground state. Since the normal carbon dioxide molecule is in a $^1\Sigma$ state, it cannot be formed from normal CO($^1\Sigma$) and normal oxygen O(^3P); thus in the combustion an electronic rearrangement must take place at some stage, the most likely stage being after the formation of the carbon dioxide molecules. The electronic transition may take place either freely by radiation, or on collision, but in either case will leave the carbon dioxide molecules in the ground electronic state with excess vibrational energy. It is these vibrationally activated molecules which are believed to be responsible for the afterburning. It has been shown from consideration of supersonic dispersion in pure carbon dioxide and from calculations of radiative life-times that these activated molecules may persist for an appreciable fraction of a second; moreover, the presence of such activated molecules will lead to abnormal dissociation. This concept of vibrationally activated carbon dioxide molecules agrees with Garner's conclusions from measurements of infra-red radiation, and is particularly successful in explaining the failure to observe the band at 14·9 μ in emission. The marked catalytic action of water in promoting the combustion and reducing the infra-red emission from burning carbon monoxide readily falls into line on this theory, as it is known from supersonic measurements that water molecules are extremely effective in deactivating vibrating carbon dioxide molecules.

Quantitative objections to David's original hypothesis of electronically activated carbon dioxide and water molecules were pointed out by Egerton and Ubbelohde[5] at the time of announcement, it being stressed that the amount of radiation emitted was insufficient to account for the large amount of latent energy reported. Gaydon has since pointed out that as carbon dioxide, even in the liquid state, is quite transparent throughout the visible and quartz ultra-violet regions of the spectrum, there cannot well be any low-lying electronic states of carbon dioxide to account for the latent energy. If an electronic state of high energy is involved, then Egerton and Ubbelohde's arguments must hold, and also the afterburning gases would be expected to show properties even more remarkable than those of active nitrogen. The hypothesis of vibrationally activated molecules seems also to be more successful in explaining the abnormal dissociation, the effect of pressure waves in causing the afterburning gases to luminesce brightly, and the failure to observe the 14·9 μ band of carbon dioxide in emission from explosion flames, than does the hypothesis of electronically activated molecules. It must be pointed out that David[3] speaks of the radiation from afterburning gases being emitted during a *collision*; the spectrum of the carbon monoxide flame shows that the radiation has a discrete structure and must therefore be emitted by a molecule in a quantized energy state, not by a collision. David also speaks of observations by Kitagawa and by Gaydon of the emission spectrum of activated water molecules in flames; this is true; the analysis shows, however, that the water molecules are *vibrationally* activated. No stable electronic state of the water molecule which could possibly account for the latent energy is known. Although the vibration-rotation spectrum of water is strongly emitted by the hydrogen flame, it is probable that in this case the emission is thermal in origin; there does not appear to be any evidence to indicate that vibrating water molecules have an abnormally long life, and it is unlikely that they contribute appreciably to any afterburning.

A discussion of the afterburning problem also raises the fundamental question as to whether or not pure gases luminesce when heated to temperatures as high as those produced in explosion flames. If, as is frequently stated, hot gases do not radiate, then the case for the existence of some form of afterburning is proved without more ado, because there can be no doubt that under some conditions freshly burnt gases do continue to luminesce, and if this luminescence is not thermal in origin, it must be due either to continued combustion or to some form of activated molecule. Lewis and von Elbe have expressed doubts as to whether the common assumption that hot gases do not luminesce is really correct, and Gaydon retained an open mind, merely recording[6] that he was unaware of any experiments at sufficiently high temperatures. It must be remembered that in closed-vessel explosions sound, or even shock, waves caused by the explosion may produce momentary local heating considerably above the theoretical maximum temperature, and that such experiments as those of Pringsheim do not cover these very high temperatures. For the permanent gases, nitrogen, oxygen and carbon monoxide, there is little reason to expect luminescence at the temperatures attained in ordinary gas explosions, but for carbon dioxide there will certainly be some dissociation at high temperatures, and there would not appear to be any real distinction between the recombination following this dissociation and normal combustion, so that emission of the type found during the combustion might be expected when carbon dioxide is strongly heated.

Nevertheless, the quantitative measurements of the amount of radiation from the carbon monoxide flame made by Kondratjew show clearly that the visible radiation from this flame is a result of the chemical action and is not purely thermal, and this is supported by the observation of a cool flame for carbon monoxide, the emission spectrum of which has recently been found by Gaydon to be similar to that of the normal flame. Since the bulk of the emission from the ordinary flame is due to chemical and not to thermal causes, there seems little doubt that in the observed cases of afterburning the emission is also the result of chemical action rather than mere heating effects. This is supported by David's recent note[7], in which he stresses that the intensity of the afterburning depends on the condition of the gases and not solely on temperature. Also, spectrograms of afterburning gases in the internal combustion engine[8] show almost complete identity with the ordinary flame spectrum of moist carbon monoxide *including the presence of the OH bands*; the identity of these spectra would appear to support the view that the afterburning is really due to continued burning rather than to thermal emission or to emission from electronically activated molecules.

The determination of latent energy in flames also involves the difficult problem of measuring flame temperatures accurately. The two most favoured methods are the sodium line reversal method and platinum resistance thermometry. The sodium line reversal method has been severely criticized by David, and recent developments seem to show that this criticism is justified; it is known that the reaction

$$H + H + Na = H_2 + Na^*$$

may result in unduly strong emission from the hydrogen flame, and it has now been found that strong emission of the sodium lines occurs in the cool flame of carbon monoxide at temperatures around 600° C., so that in the combustion of carbon monoxide it is also probable that the excitation of the lines is chemical rather than thermal. Lewis and von Elbe have, in turn, criticized David's use of the platinum resistance thermometer, saying that insufficient allowance was made for radiation losses. Radiation losses can, of course, be compensated for, but another possible objection is that catalytic action at the surface of the wire (compare the action of palladium in promoting surface combustion) may cause the wire to record too high a temperature; actually the platinum resistance wire usually gives lower temperatures than the sodium line reversal method, and is probably the more reliable if due care is taken to compensate for heat losses. While the exact amount of latent energy in flames may remain in doubt, the definite rise in temperature of dry carbon monoxide flames when a trace of moisture or hydrogen is added shows that for carbon monoxide, at least, there is some latent energy.

It should be stressed that the semi-quantitative development of the concept of vibrationally activated carbon dioxide molecules is successful in explaining the abnormal dissociation and therefore the afterburning of dry carbon monoxide, but that for fuels rich in hydrogen it seems unlikely that it could account quantitatively for any afterburning or latent energy of long duration, although it may still explain such effects if of much shorter duration (perhaps less than 0·1 sec.).

Apart from the afterburning, 'live' flame gases show other very marked properties that are not common to mere hot gases. Experiments by Egerton and Gaydon show that they are more highly ionized, and appear to possess the property of igniting other combustible mixtures. Spectra of afterburning gases show the presence of OH radicals. It is known[9] that under discharge tube conditions OH radicals have a life of at least 0·4 sec. At atmospheric pressure their life will presumably be much shorter, but the persistence of a trace of these radicals might account for some of the peculiarities of 'live' exhaust gases. It has also been found spectroscopically that if flame gases are chilled by contact with cool metal surfaces, either peroxides or HCO radicals are carried through in the products. At the temperature of the freshly burnt gases, these reactive constituents may continue o react with any excess oxygen and may, as in certain cool flames, maintain chemically a small concentraion of highly activated molecules.

It may be concluded that the afterburning and other peculiarities of the combustion of dry carbon monoxide are best explained in terms of vibrationally activated molecules, and cannot well be due to carbon dioxide molecules of abnormal structure (electronically activated). Similar afterburning and latent energy in the combustion of ordinary fuels, if of short duration, might be due to the same cause, but any such ffect of long duration would require an alternative xplanation. The persistence of radicals and reactive ntermediary products of the combustion may exlain some of the abnormalities of 'live' flame gases.

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GALILEO, NEWTON AND HALLEY

ON Friday, October 9, the Royal Astronomical Society held a meeting at its premises in Burlington House in celebration of the tercentenary of the death of Galileo Galilei (1564–1642) and the birth of Isaac Newton (1642–1727) and the bicentenary of the death of Edmond Halley (1656–1742). An exhibition of portraits and other memorials of the three astronomers, collected from various sources and arranged in the Grove-Hills Library, aroused considerable interest, after which a large gathering, presided over by the president of the Society, Prof. S. Chapman, and including representatives of the Royal Society, the Royal Academy, the Royal Institution, the Royal Geographical Society, the Royal Meteorological Society, the Physical Society, the Imperial College of Science and Technology, the Science Museum, the British Astronomical Association, the British Council, the Fighting French and other bodies, assembled in the meeting-room.

The proceedings opened appropriately with a short account by Mrs. M. E. Evershed of the lives and outstanding characteristics of Galileo, Newton and Halley, and this formed a fitting introduction to papers on their scientific achievements by Prof. H. Dingle, Prof. H. C. Plummer, and the Astronomer Royal, Dr. H. Spencer Jones. The contrast in character of the three men was well brought out by Mrs. Evershed—Galileo intensely alive, active and eager, Newton reserved and difficult to understand, and Halley sociable and friendly, with a sunny, open nature.

Prof. Dingle summarized Galileo's chief contributions to modern thought—which takes its form mainly from his work—under three headings. First, Galileo originated the scientific method as a definite, consciously adopted, philosophical procedure. He was the first to make it his specific aim to discover how things worked and not why they worked so. This followed from his new view of the works of Nature as objective existences which man was able, though not without great pains, to understand, instead of as instruments designed to meet man's requirements. Galileo's destruction of the anthropocentric system of philosophy was more vital for subsequent thought than Copernicus's destruction of the geocentric system of astronomy.

Secondly, having prepared the ground for science, he laid its foundations and began the building. He made possible the mathematical study of motion by representing time as a measurable geometrical extension, and himself made considerable progress in that study. He arrived at what we call Newton's First Law of Motion; realized the significance of inertia; showed that falling bodies, whatever their weight, exhibit the same uniform acceleration, and that projectiles describe parabolas; went a long way towards the formulation of Newton's Second Law of Motion and the discovery of the calculus, which, in fact, he actually used; and stated clearly the principle of relativity, which Einstein had to restore in 1905 after unwarranted violation.

Thirdly, Galileo's contributions to pure astronomy consisted, first, in the establishment of the general principle of the uniformity of Nature by the abolition of the supposed distinction between the perfect heavens and the imperfect earth, and next in the independent invention of the telescope and the enlargement of the field of possible knowledge by a greater factor than that achieved by any man before or since. With an instrument vastly inferior to even the most modest of present-day telescopes, he discovered the irregularity of the surface of the moon, the multitude of the fixed stars, the stellar character of the Milky Way and of some 'nebulæ', the four great satellites of Jupiter, sunspots and the sun's rotation, the phases of Venus, the abnormality of Saturn, and the cause of the 'secondary light' (earthshine) on the moon.

As a writer, Galileo's chief characteristic was his almost complete modernity. He thought and expressed himself in a manner which makes an instant appeal to us of the present day and stands in striking contrast to the medieval style of Kepler, who was, in fact, his contemporary. But while he opened his mind with perfect candour, he rarely showed the feelings with which, for the first time in history, he saw a new universe unrevealed to the naked eye.

Prof. Plummer, in a wide survey of Newton's various activities, stated that his religious life was normal and characteristic of a man of the seventeenth century ; it must not be judged from a modern point of view. What was curious was that that view was the result largely of the success which had attended the Newtonian system of natural philosophy. It was an undesigned effect not contemplated by Newton, but the cruder form of scientific determinism was reached as early as the eighteenth century, and its extreme exponent was probably to be found in Laplace.

Newton's removal to the Mint in later years may have represented a loss to science, but that should not cause the importance of his work there to be underestimated. It was required at a time of crisis in the financial history of Britain, and his work was carried out efficiently, honestly and expeditiously.

Newton gave much time to chemistry, but the results proved sterile. In physics it was otherwise, and the subjects of heat and electricity bore the impress of his work. But it was in optics that Newton not only made important and famous contributions, but also exercised the greatest influence on subsequent developments. This influence was not altogether fortunate. There is much that is suggestive and subtle in his views, but the fact remains that his authority was long quoted against the undulatory theory, and was therefore detrimental to a necessary stage in the progress of optical development.

The mathematical achievements of Newton were undeniably great. Owing to late publication they cannot be said to have influenced contemporary progress as they should have done, and even to-day it is doubtful if they are generally appreciated as they deserve to be. It is therefore pleasanter to dwell on the "Principia" and to see in it the true monument of Newton's greatness as well as the triumphant culmination of the story which began with Kepler's "Astronomia Nova" in 1609 and the work of Galileo collected in the "Discorsi" of 1638, and follow these two lines through Horrocks in celestial mechanics and Huygens in dynamics. There was much to be done to advance from the undergraduate ideas conceived at Woolsthorpe before the riddle of the universe could be solved, and it was not accomplished by one man alone. But when the answer came, it was so complete in its development that without Newton a long delay would have been inevitable, for the "Principia" not only revealed the law of gravitation, but also taught how it was to be applied.

The Astronomer Royal directed attention first of all to Halley's great versatility. He was at once mathematician, astronomer, physicist and statistician ; geographer, hydrographer and geomagnetician ; navigator, practical seaman and the first scientific voyager ; scholar, diplomat and man of affairs ; and in every branch of knowledge that he cultivated he achieved distinction. His favourite pursuit, however, was astronomy, to which he decided to devote himself at the age of sixteen. In 1676, when he was twenty years old, he set sail for St. Helena, where he remained for a year for the purpose of determining the positions of the southern stars, which had not up to then been properly observed.

Halley's greatest service to human knowledge, however, was the share that he took in bringing Newton's "Principia" before the world. As de Morgan has said, "but for him, in all human probability, that work would not have been thought of, nor when thought of written, nor when written printed". Having extracted from Newton a determination of the law of force (the inverse square law) under which planets move in elliptical orbits with the sun in a focus, he realized better than anyone else the importance of the matter, and persuaded Newton to develop his results and to communicate them to the Royal Society, of which Halley had been appointed clerk. The Society decided to print the work (the first book of the "Principia"), but found itself without funds, whereupon Halley undertook to defray the cost himself. The second and third books were presented later, and Halley again rendered a great service by persuading Newton to abandon his intention of withdrawing the latter.

Newton's work was followed up by Halley himself, first by directing attention to the effect of the mutua gravitational attraction of the planets on their motions, but chiefly by his investigations of the orbits of comets. He collected all available observations ; devised an arithmetical calculus for computing the orbits, and provided tables for facilitating the computations ; and made the first definite prediction from Newton's law of gravitation by his prophec that the comet now known by his name would appea again in 1758.

Halley next turned his attention to the neglected field of Greek geometry, in which he did valuable work and to the problems of the earth's magnetism. Thi led to his being given a commission in the Roya Navy, in charge of His Majesty's Pink, *The Paramour* He made several voyages, as a result of which h published charts of the variation of the compass ove the Atlantic Ocean and over the whole world, show in the now universally used form of isogonal lines and made a survey of the tides in the English Channel

Halley was the first to point out the possibility o determining the sun's parallax accurately fron observations of the transit of Venus, and his effort led to expeditions being sent out to observe th transits of 1761 and 1769. He was also the discovere of the proper motions of stars. In 1720, at the ag of sixty-four years, he succeeded Flamsteed a Astronomer Royal, and turned his chief attention t the improvement of the current tables of the moon for the purpose of determining longitudes by th method of lunar distances.

Halley was a man of genial disposition, quick an vivacious, with a keen humour and a gift for friend ship. In commemorating the bicentenary of Halley' death, it is appropriate to recall the conclusion of th Latin inscription on his tomb, which in translatio reads : "As when living, he was so highly esteemed b his countrymen, gratitude requires that his memor should be respected by posterity."

OBITUARIES

Prof. G. G. Henderson, F.R.S.

George Gerald Henderson was born at Glasgow on January 30, 1862. After preliminary education at a private school he proceeded to the University of Glasgow where, taking up the study of chemistry, he graduated B.Sc. in 1881 and later on took also an honours degree in arts. He spent in addition some time in Leipzig studying chemistry with Johannes Wislicenus. In 1884 he joined the staff of the Chemistry Department at the University of Glasgow under Prof. John Ferguson, and about the same time he became secretary to the Glasgow Section of the Society of Chemical Industry, carrying out the duties of the post with great acceptance until 1893, thus beginning a connexion with that body which became closer and closer to the end of his life.

In 1889 he became lecturer in chemistry at Queen Margaret College, the women's branch of the University, where he had practically an independent department. In 1892 he was appointed to succeed Prof. William Dittmar in the Freeland chair of chemistry at the Andersonian College, and in his twenty-seven years in this post he did the chief part of his lifework. At the time of his appointment the laboratories and equipment were very archaic, and he had to work in these adverse conditions for a good many years. In 1901, however, the fine new buildings of the Royal Technical College were commenced and in 1905 they were completed, Henderson having given much time and thought to their planning and equipment. Some ten years later he was active in a consultative capacity when, in 1913, the affiliation of the Royal Technical College with the University in respect to engineering and other applied subjects was carried through.

During all these years Henderson was steadily developing his department, and especially instilling an appreciation of research work in chemistry into a considerable number of senior students. Henderson being an all-round man, his work was on various subjects. It included the investigation of salts of some hydroxy acids, action of ammonia on metals at high temperatures with the late (Sir) George Beilby, molybdenum and tungsten derivatives of lactic acid, etc., but his work tended more and more in the direction of terpene chemistry; to investigation of the action of chromium oxychloride, hypochlorous acid and hydrogen peroxide on camphene, pinene, bornylene and limonene, with the relationship of borneol and isoborneol and of camphene and bornylene, and other similar problems. It is with this that his name s most likely to be associated in the future. In it he has had many collaborators, who are carrying the work begun with him to further stages.

During 1914–15 he was president of the Society of Chemical Industry; in 1916 he was elected a fellow of the Royal Society, and he was also in that year president of Section B of the British Association; in 919 he was appointed to the regius professorship of hemistry in the University of Glasgow. There he had under his own particular charge the junior and he senior inorganic work, but he carried on as well, with various assistants, his investigations on terpenes nd other subjects. He devoted himself, at the University, with great assiduity to the routine of his department, and played a very active and useful part on the business side of University affairs in many capacities. He was dean of the Faculty of Science for three years, member of the Library Committee for three years, and for eight years, from 1925 until 1933, he was a member of the University Court. He also planned with the architect the major part of the new chemistry buildings. It is clear from his career that he has always been regarded by others as a man of affairs whose wise counsel was held in high esteem.

While at Glasgow he was president of the Institute of Chemistry during 1924–27 and president of the Chemical Society during 1931–33. At seventy years of age the railway travel which the last office entailed meant for one, even of his robust constitution, a considerable strain. In 1937 there came to him, as a peculiarly fitting tribute at the end of a long and active life spent in promoting chemistry and chemical industry, the award of the Medal of the Society of Chemical Industry, a recognition conferred in alternate years for "conspicuous service rendered to applied Chemistry by research, discovery, invention, or improvements in processes".

Henderson was so well known that anything about his personality may seem superfluous, but for those who had not met him it may be said that he was of full middle height, spare of form, with brown moustache which never altered its shape in obedience to the dictates of fashion. In fact, Henderson was one of the most unchangeable of men. He always smoked the same kind of pipe and the same kind of tobacco; he always wore the same kind of eye-glasses—no tortoiseshells for him; always the same type of clothing, well tailored, rich not gaudy; and he had the kind of figure that a tailor must rejoice in. The writer was one of the students at the old Andersonian College on the day that Henderson was inducted to his new charge, and it is hardly any exaggeration to say that since then he had altered not at all when he took his last farewell of us in 1937.

He had a rather deliberate manner of speech which, in most anecdotes, crystallized into "Ah, yes", and it often helped to make his replies effective; he was not easily taken at a disadvantage. Once during the big strike of 1926 he came into the writer's room and mentioned casually that he had just been interviewed by a student who had started the conversation by explaining, in very truculent fashion, that his father was a working-man. "Ah," said G. G., "I'm very glad to hear that. So was mine!"

He had decided to retire at the end of September 1937 and he looked forward to a peaceful time at Horsaclett, the house he had bought some years previously near Tarbert, Harris, and where he indulged himself in what was certainly his chief sporting interest, fishing. Mrs. Henderson (his cousin Agnes Mackenzie Kerr whom he had married in 1895 and whom everyone who knew her remembers with pleasure) went north in early summer, as she usually did, to get things ready, but shortly after arrival at Tarbert she died suddenly of heart failure. Thus, just on the threshold of the quiet companionship they had looked forward to, and which indeed had always been their ideal, his hopes were utterly dashed. It was a stunning blow which Henderson bore with stoical fortitude. He had never been accustomed to wear his heart upon his sleeve, and he did not do so then, but the rest of his life can have been little more than patient endurance. Outwardly, however, he remained what he had always been until about the middle of last June, when he rather suddenly became ill and was removed to hospital with the prospect of an operation. This could not be fully performed, and, back in his home, he gradually sank, clear in mind while slowly wasting away, until the end came on September 28. In unostentatious fashion he had lived an active, useful life, and he will be remembered with gratitude and affection by many old students and colleagues, the world over. He died in surroundings very dear to him, and there he now rests beside his beloved companion of more than forty years.

T. S. PATTERSON.

Prof. H. D. Wright

THE death of Hedley Duncan Wright at his home in Liverpool, on September 9 at the early age of fifty-one, has deprived bacteriology prematurely of one of its most distinguished and indefatigable workers.

Wright was born at Ulverstone, Tasmania, on March 3, 1891. He arrived in Great Britain in 1910 to read medicine at the University of Edinburgh after taking his B.A. in classics at the University of Tasmania. While still a student he served as a dresser in the Scottish Red Cross Unit in Serbia during the second Balkan War. In 1916 he graduated in medicine with first class honours and immediately joined the R.A.M.C., in which he held a commission until 1920. He saw active service in France, India and East Persia. His first appointment after demobilization was as lecturer in bacteriology at Edinburgh under his old professor (James Ritchie). During 1921–23 he was the assistant superintendent of the research laboratory of the Royal College of Physicians, Edinburgh, where he obtained valuable experience in statistical methods from the director, A. G. Kendrick, later to be of great value to him in his research work.

In 1923 Wright was appointed lecturer in bacteriology at University College Hospital, London, becoming University reader in 1928. It was here, working under A. E. Boycott, that he first embarked on those studies in clinical bacteriology, notably subacute infective endocarditis and pneumococcal septicæmia, which first directed the attention of his colleagues to his outstanding ability. The submission of a thesis on this work, which has since become classical, earned for him in 1925 the Edinburgh M.D., with gold medal, and the D.Sc. followed in 1927. In 1930 he became the first holder of the newly created chair of bacteriology in the University of Sydney, where he remained for four years. In 1934 he was invited to succeed J. M. Beattie as professor of bacteriology in the University of Liverpool and bacteriologist to the Port and City of Liverpool.

In addition to these academic posts, the recognition of Wright as an eminent authority on his subject led to his appointment in 1937 to the Bacteriological Committee of the Medical Research Council, where his wide personal experience and deep knowledge of the literature were often of great assistance; in 1939 he served on the Council's sub-committees on cross-infection in hospitals and on diphtheria immunization. He joined the Pathological Society of Great Britain in 1921, and performed invaluable work as assistant editor of the journal, first during 1928–30 and again from 1937 until his death. Many contributors have had reason to be grateful for the careful scrutiny which he gave their papers.

Wright's scientific work was noteworthy for its thoroughness and attention to detail, and his papers are models of lucidity. Perhaps his most important contribution was the convincing demonstration that the blood of a patient with subacute infective endocarditis was actively bactericidal, a conclusion made possible by his use of methods of quantitative cultivation. This necessitated research into the factors which tended to inhibit the growth of delicate pathogens in artificial media, and "Wright's" broth is well known as an excellent and easily prepared medium for the cultivation of such organisms. He always contended that one should work on problems which lay ready to hand for solution, so it was not surprising that when he came to Liverpool and found himself in charge of a large public health laboratory he should start investigations on the epidemiology of diphtheria, especially cross-infection in diphtheria wards, which had far-reaching practical results, and on the reliability of bacteriological analysis of water supplies. Many improvements in the technique for the isolation of intestinal pathogens also emanated from his laboratory, and he took the opportunity of a recent outbreak of paratyphoid *B* fever to write a masterly account of its bacteriology.

By his death, the University of Liverpool has lost a wise administrator and a stimulating teacher. He was one of the ablest of committee men, and no sub-committee of importance in the Medical Faculty was appointed which did not include him. At various times he acted as external examiner to the Universities of Leeds, London and Manchester.

Though ill-health attended Wright's later years it was borne with characteristic fortitude. He married in 1917 Matilda B. Spittal. Her death barely a month before his own was a grievous blow. Their three sons survive them.

A. C. T. VAUGHAN.

NEWS and VIEWS

Prof. J. K. Parnas

PHYSIOLOGISTS and others will be glad to learn from the following extracts from a card received by Prof. A. V. Hill that Prof. J. K. Parnas, till 1939 professor of medical chemistry in the University of Lwów, escaped to the U.S.S.R. and is alive and well:

"I am still in Ufa, in the Bashkiria, with my wife; my son is in Central Asia, in the Polish army. All my people, my pupils and friends, remained in Lwów, unfortunately, and I do not know anything certain about their fate. I myself had a narrow escape, the events have been so quick. I am living here quite comfortably and have good company of people from the Western Russian cities, and I am treated with so much consideration and given everything that can be given from the moment when they received me from Lwów. From time to time I am getting news of your activities through notices in NATURE and other periodicals. I hope the strange and tragical perturbations through which we are given to live will sometime ebb down, and I shall see my liberty, and my town again, and perhaps also my Western friends—and join them at some Physiological Congress. But verily I never shall forge these good and brave people here, and the time was living among them."

Population Statistics

The National Institute of Economic and Social Research is planning the issue of Occasional Papers to make quickly available the results of research which are of particular current interest. The first to be issued deals with "The New Population Statistics" and has been written by R. R. Kuczynski, a leading authority on the subject of population. The paper is a critical review of a memorandum presented by the Registrar-General to the Royal Commission on the Geographical Distribution of the Industrial Population more than three years ago but only recently made public. The author bases his criticism on a searching analysis of certain new fertility data collected under the Population (Statistics) Act of 1938, published this year in the Registrar-General's Statistical Review of England and Wales for 1938 (Tables, Part II, Civil), to which all students of population problems had been looking forward eagerly.

The study is divided into four short chapters. In the first two, Dr. Kuczynski discusses the new data and some of the results which may be deduced from them. In the last two he attacks the forecasts of the future population of Great Britain made by the Registrar-General and the remedies he proposes for them. The position, as the author sees it, is concisely stated in the final paragraph, which deserves quotation: "It would be most regrettable if the Registrar-General's conclusions should induce the general public to believe that the prevention of a population decline is an easy matter which can be achieved any time by very simple and immediately effective means. It is now more important than ever to realize that Britain's population problem is a serious problem and extremely difficult to solve. Fortunately, the new population statistics, if perused judicially, will somewhat facilitate that task."

Geology of the U.S.S.R.

According to the *Soviet War News*, reports from the Geological Committee of the Council of People's Commissars indicate that more than two thousand expeditions went out during the summer, and discovered valuable new deposits of strategic raw materials. A feature of war-time geology is that the exploitation of new deposits begins much earlier than it did in peace-time. New deposits of aluminium ores have been discovered in the Urals, in Western and Eastern Siberia, and also in Kazakhstan. The exploitation of newly discovered antimony and mercury deposits has already begun. Rich sources of iron ore, fluxes and fireproof minerals for the iron and steel industry have been opened up in the Urals, Siberia and the Central Asian Republics. Prospecting for combustible shales is meeting with success in the Urals and Eastern Siberia. Particularly important, from the point of view of defence, is the discovery of new sources of manganese. Several new manganese mines are already functioning in the Urals, Western Siberia and Kazakhstan. During seven months of 1942 the output of manganese ore in these regions was 250 per cent greater than in the parallel period of 1941.

Coal mines are being developed in the immediate vicinity of the Urals iron and steel industries. More than ten coal pits have been sunk in the recently discovered deposit in the middle of the Kizelovo district, and are already in production. An exhibition of the mineral wealth of Tadjikistan, the Soviet Republic north of Afghanistan, opened in Stalinabad, contains a collection of seventy specimens of useful minerals recently discovered in the Pamirs and in the mountains of Gissar and Zeravshan; among them are iron ore, tin, wolfram and lead.

The Leningrad Botanical Institute

The Leningrad Botanical Institute, the largest in the U.S.S.R., has not suspended its work under conditions of war and siege. The Institute has a rich botanical collection of some seven million specimens of plants. Its library contains 135,000 volumes on botany, while more than 20,000 specimens of plants from all parts of the world are to be found in its gardens laid out about 230 years ago on the order of Peter the Great. The hothouses alone of the Institute occupy an area of 35,000 square metres.

During the autumn of 1941, 193 scientific research workers and employees of the Institute remained in the city in order to preserve this valuable property, and not only did they preserve it under the very difficult conditions of the past winter but they also continued their scientific research work. While the Germans were shelling the city Prof. Rozhevits completed his monograph entitled "The Biology and the Economic Importance of the World's Cereal Plants".

Official Recommendation of Insecticides and Fungicides

With the concurrence of the Agricultural Improvement Council, a scheme under which official approval can be given to proprietary insecticides and fungicides for the control of plant pests and diseases has now been agreed by the Agricultural Departments of Great Britain and the Association of British Insecticide Manufacturers. The Minister of Agriculture and Fisheries and the Secretary of State for Scotland in consultation with the Agricultural Research Council, have appointed the following Committee to advise on applications from manufacturers for the approval of their products under this scheme: Prof. J. W. Munro (*chairman*), Dr. C. E. Foister, Mr. C. T. Gimingham, Mr. A. J. Holden, Dr. Hubert Martin, Mr. W. C. Moore, Dr. D. D. Pratt, Dr. H. Shaw, Dr. J. T. Martin (*secretary*). This Committee will be responsible for recommending approval. The principles and conditions of approval for the various groups of products will be drawn up by a joint panel composed of the members of the Committee, together with four representatives of the Association of British Insecticide Manufacturers, a representative of the Government Chemist and a representative of the Agricultural Research Council. This Joint Panel will also consider any points of principle arising out of particular products submitted for approval. Particulars of the scheme may be obtained from the Secretary of the Committee, Plant Pathological Laboratory, Ministry of Agriculture, Milton Road, Harpenden, Herts.

Study of the Atomic Nucleus

The University of Manchester branch of the Association of Scientific Workers has organized a series of lectures which are being given by scientific men engaged in research. The lectures are to cover various scientific topics, and it is hoped that they may help to establish contacts between scientific men working in widely different fields. Lectures have been given on "Relativity", "Heredity" and "Organic Chemistry". A meeting on October 14 was addressed by Dr. S. Tolansky on "The Study of the Atomic Nucleus by Spectroscopic Methods". After a short historical introduction, Dr. Tolansky discussed the spin of an atomic nucleus as one of the causes of the hyperfine structure of spectral lines. The importance of experimental technique in the study of hyperfine structure was stressed, attention being devoted to both sources and instruments. Typical hyperfine structures were illustrated and their interpretations discussed. It was pointed out that hyperfine structure investigations have yielded valuable information about nuclear moments, isotope abundance ratios, nuclear volumes and shapes of atomic nuclei. A theory of Landé was discussed according to which the spin and magnetic moments of atomic nuclei are determined by the spin and orbital motion of one neutron or proton only.

Indian Association for the Cultivation of Science

THE annual report of the Indian Association for the Cultivation of Science for the year 1941 includes the report of the committee of management and a list of papers published in the *Indian Journal of Science*, vols. 14 and 15, together with a report by Prof. K. S. Krishnan on the scientific work of the Association. This includes an account of magnetic studies on gadolinium sulphate octahydrate and of the spin-orbit coupling in cobaltous ions deduced from the magnetic properties of blue cobalt salts, in which results were obtained strongly supporting the theoretical prediction that there should be an inversion of the Stark pattern, first in a given cubic field as we pass from cobaltous to nickelous ions, and second for either of these ions as the disposition on the negative ions surrounding them changes from a tetrahedral distribution to an octahedral one. Reference is also made to magnetic measurements on a large number of cupric Tutton salts at low temperatures, in which also the cuprous ions possess practically the same type of anisotropy as in copper sulphate pentahydrate. The paramagnetic properties of several other salts of the iron group have been studied at low temperatures, and reference is made to the results obtained with some of the complex salts such as potassium ferricyanide. Preliminary measurements on the magnetic properties of mobile electrons in condensed ring hydrocarbons such as anthracene, chrysene, pyrene, etc., indicate that there is a decrease of the order of a few per cent of the diamagnetism of the mobile electrons as we pass from room temperature to about 300°. The metallic nature of the mobile electrons in aromatic molecules is supported by the observation that the absorption bands in the violet and in the near ultraviolet regions in anthracene crystals, presumably due to the mobile electrons, are paralleled by the strikingly selective refraction of the crystals in the region of these absorption bands, those wave-lengths that are strongly absorbed by the crystal being those that are strongly reflected from its surface. Measurements on the polarization of fluorescence of anthracene, phenanthrene, chrysene, and naphthacene in highly viscous solutions lead to the conclusion that the fluorescence is due either to a single linear oscillator or to a set of linear oscillators that radiate independently.

Institute of Tropical Medicine at Havana

THE August issue of the *Boletin de la Medicina Sanitaria Panamericana* contains an account of the Institute of Tropical Medicine of the University of Havana. It was created on December 8, 1937, under the direction of Dr. Pedro Kourí, who is professor of parasitology and tropical diseases at the University. Its function is threefold: teaching, research and treatment. The courses of instruction are attended by students and post-graduates, many of whom are foreigners. Most of the research is devoted to studies of hookworm, echinococcus, bothriocephalus, ascaris, strongyloides, fasciola, amœba and a new intestinal parasite first described in 1935, *Inermucapsifer cubensis* Kouri. The institute contains a Finlay Museum, which has a collection of anatomical specimens, parasites and other teaching material on permanent exhibition, laboratories, a department for drawing, photography, microphotography and microcinematography, and a free dispensary. In co-operation with other agencies, the institute carries on a campaign of popular education and prophylaxis against intestinal parasites. The official organ of the Institute is the *Revista de Medicina Tropical*.

Recent Earthquakes

A SLIGHT earthquake causing neither damage nor casualties took place at Almora in the United Provinces, India, on October 10, 1942.

A strong earthquake swarm has recently occurred in the Azores. All the islands have been affected, though the tremors were particularly violent in the Island of Fayal and in Sao Jorge. The shocks were continuing on October 17. Strong faulting has become apparent across the island of Fayal, and buildings have been affected. Further news is awaited from the islands and from seismological observatories.

Announcements

PROF. J. D. BERNAL, professor of physics at Birkbeck College, University of London, will deliver the first Sir William Bragg Memorial Lecture of the Chemical Society on November 19, at 2.30. The Lecture will be given at the Royal Institution, Albemarle Street, London, W.1.

PROF. P. A. BUXTON, director of the Department of Entomology of the London School of Hygiene and Tropical Medicine, will deliver the first Bacot Memorial Lecture of the Lister Institute of Preventive Medicine on October 30 at 3 p.m. The Lecture, which will be entitled "Bacot's Work on the Louse and some of its Recent Developments", will be given at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, and is open to the public.

THE following appointments and promotions in the Colonial Service have recently been made: E. Bellis, agricultural officer, Kenya; S. H. Crowdy, agricultural superintendent, Gold Coast; A. C. Trueblood, agricultural officer, Nigeria; P. E. Weatherby, botanist, Uganda; B. C. Willis, agricultural officer, Northern Rhodesia; H. C. Dawkins, assistant conservator of forests, Uganda; B. Gilchrist, assistant conservator of forests, Tanganyika Territory; R. W. J. Keay, assistant conservator of forests, Nigeria; G. A. Steven, fisheries development officer, Sierra Leone; C. L. C. Bourne (assistant chemist), government analyst, British Guiana G. R. G. Kerr (senior assistant conservator of forests), conservator of forests, Nigeria; D. E. Faulkne (veterinary officer, Gold Coast), principal veterinary and agricultural officer, Swaziland; A. H. S. Vig (senior assistant agricultural officer), agricultura officer, Nigeria.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

On "Absolute Acceleration"

It is of interest to consider, in this the year of Newton's tercentenary, the present position of *acceleration* in Newtonian mechanics. The Newtonian equations of motion of a particle *in free space* are unaltered in form, as is well known, on transformation to any other frame in uniform relative motion, but this is not true for transformations to relatively accelerated frames. Hence the notion of "inertial frames"—frames for which the Newtonian dynamics holds good—frames for the existence of which, according to Einstein and Infeld in their book, "The Evolution of Physics", physics has been unable to account. The existence of inertial frames appears to indicate that any particle in the universe possesses an absolute acceleration.

But the universe is not 'empty space'. It is populated with galaxies, receding from one another and approximately (in the large) uniformly distributed. If we move our frame of reference from our own galaxy to the nucleus of an external galaxy, we should expect the Newtonian mechanics still to hold good—we cannot assume our own galaxy privileged. But according to Newtonian mechanics itself, a new term should appear in the equations of motion referred to the distant nucleus, a term arising from the acceleration of that nucleus relative to our own galaxy. Hence mechanics, in the distant galaxy, cannot be Newtonian, and we are driven back to assuming ourselves in a privileged position.

The explanation of this paradox can be deduced from two papers[1, 2] in 1934 on "Newtonian Expanding Universes", the first by myself, the second by Prof. W. H. McCrea and myself working in collaboration. We there showed that the relativistic equations of the expanding universe are identical in form with those derived on elementary Newtonian mechanics and gravitation combined with the hydrodynamical equation of continuity, provided that a nebular nucleus P is assumed to be under the gravitational attraction of all the matter inside a sphere centred at the observer O and of radius OP, O being supposed unaccelerated. The velocity-distance law of Hubble then followed. The deeper significance of this result was left over for further research. It is now clear that if the roles of O and P are interchanged, P should be able to assume himself as unaccelerated and O as having an acceleration determined by the matter inside the sphere of centre P, radius PO. In other words, the term in the equations of motion which would be expected on transforming from O to P is annihilated by the changed attraction of the matter of the universe.

This means that there is no such thing as absolute acceleration. By appropriate choice of observer O we can make P's acceleration what we will. Just as the Newtonian relativity of velocity can be stated in the form: "It is possible to assign the velocity of any one particle in the universe *arbitrarily*; the rest then follow", so we can assert a Newtonian relativity of acceleration in the form: "It is possible to assign the acceleration of any one galaxy *arbitrarily* (and with it the acceleration of any member of it); the rest then follow." Or we may put the statement in the form of one of Prof. E. T. Whittaker's Postulates of Impotence: "It is impossible to determine the absolute acceleration of any particle in the universe." The reconciliation of this state of affairs with the apparent conflict with the naïve view of Newtonian mechanics enunciated earlier is that we are not entitled to regard any particle whatever as 'in free space'; it is always exposed to the pull of the rest of the universe, which is reckoned differently by different observers. The occupation of the universe by matter attracting according to the inverse square law is an essential condition for the existence of inertial frames, and so for the world-wide validity of Newtonian mechanics. As in Einstein's theory, mechanics and gravitation are indissolubly connected in a proper representation of Newton's theory. We are indeed "encompassed by a great cloud of witnesses"—the hypothetical observers associated with the uncountable extra-galactic nebulæ that are their possible vantage-points.

Since the acceleration of any one nebula is assignable arbitrarily, the question arises whether we can go further and choose all the relative accelerations to be zero. It is clear that the extra-galactic nebulæ in a homogeneous expanding universe are 'equivalent' in the sense used by Dr. Whitrow and myself[3], and accordingly the observers associated with them can re-graduate their clocks and adopt a scale of time (t-scale) in which all the nebulæ are in uniform relative velocity. This leads to kinematic relativity, which, as I have shown in a recent series of papers[4], affords a purely deductive approach to mechanics and gravitation. The re-graduation of clocks transforms away the gravitational pulls between the fundamental particles of the universe, just as Einstein transformed away *local* gravitational fields; but it leaves persisting a gravitational field on a *general* free particle.

The non-existence of absolute acceleration has consequences which run right through physics. For example, on the classical theory of electromagnetism, an 'accelerated electron' was supposed to emit radiation, whereas an unaccelerated one did not. This result is now seen to be meaningless as it stands, for we are unable to assign a unique value to the acceleration f in Larmor's formula $\frac{2}{3}e^2f^2/c^3$. An electron on a distant nebula, if the latter is considered as accelerated relatively to us, would on the classical theory be considered as radiating; but when we take up our abode on the distant nebula itself, and regard it as now unaccelerated, does the electron cease to radiate? The explanation of this paradox is two-fold: in the first place, the scale of time in which the Maxwell theory of electromagnetism is valid is that in which the galaxies are relatively unaccelerated, namely, the t-scale, as is shown by the Lorentz invariance of Maxwell's equations; I developed the consequences of this in two papers in 1938. In the second place, the radiation calculated by Larmor's formula relates only to a small volume charge, and is invalid if an electron is a true singularity. There are other objections to the view that an accelerated electron necessarily radiates, but I am content here to point out that the non-existence of absolute acceleration requires substantial modifications in the classical Faraday-Maxwell theory.

E. A. Milne.

Wadham College,
Oxford. Sept. 26.

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[1] Milne, E. A., *Quart. J. Math.* (Oxford), 5, 64 (1934).

[2] Milne, E. A., and McCrea, W. H., *Quart. J. Math.* (Oxford), 5, 73 (1934).

[3] Milne, E. A., and Whitrow, G. J., *Z. Astrophys.*, 15, 63 (1938).

[4] Milne, E. A., nine papers in *Proc. Roy. Soc.*, A (1936–38).

Temperature Variation of Diffuse Scattering of X-Rays by Crystals

The theory of diffuse scattering of X-rays by single crystals subjected to thermal vibrations indicates that for temperatures near or above the Debye temperature, but not too high, the diffuse scattering power σ_B should be proportional to Te^{-T/T_0} where, for a cubic lattice, $T_0 = \frac{mk\,\Theta^2}{3h^2} \cdot \frac{a^2}{h_1^2+h_2^2+h_3^2}$ (T, absolute temperature; m, atomic mass in gm.; a, lattice constant in cm.; Θ, Debye temperature; k, h, Boltzmann and Planck constants; h_1, h_2, h_3, the Miller indices of the nearest Bragg reflexion).

TABLE 1.

Type of cubic lattice:	Face-centred			Body-centred		Pseudo-simple			Diamond
	Cu	Pb	Al	Li	Na	NaCl	KCl	KBr	C
Θ° K.	315	88	398	510	202	281	230	177	(1830→ 2340)*
$(h_1^2+h_2^2+h_3^2)\ T_0$° K	14450	6880	12260	3800	2970	12850	13670	14230	(89540→ 146400)

* The correct value to assume is doubtful, but is probably near 1900° K.

This expression assumes that the distribution of diffuse scattering power about the lattice point does not vary with temperature, which is true if the variation of the elastic constants with T is small. The function Te^{-T/T_0} has a maximum value for $T = T_0$, but the thermal theory as it stands does not necessarily hold up to this temperature, since when $T \rightarrow T_0$, an approximate expansion of the type $e^M = 1 + M$, which is used in the course of the derivation, becomes no longer permissible. It seems likely, however, that even a rigorous form of the theory would still give an inversion point, where the diffuse scattering, instead of increasing with temperature, would begin to decrease. Values of T_0 have been given by Sarginson[1] but these are in error by a factor of $4\pi^2$, and recalculation gives the values in Table 1.

TABLE 2.

ψ	σ_{002} (absolute)			(relative)	
	290° K.	550° K.	665° K.	550° K.	665° K.
2°	72	114	132	158	183
3°	48	77	89	160	185
5°	26·4	44	53	167	201
6°	20·5	33	41	161	200
7°	17·7	28	35	160	200
8°	15·0	25	32	167	213
9°	12·3	20	24·5	163	199
10°	9·0	16·5	20·2	183	224
11°	8·5	14	17	165	200
			Mean observed %	165	201
			Calculated %	176	207

ψ	σ_{004} (absolute)			(relative)	
	290° K.	550° K.	665° K.	550° K.	665° K
1° 25′	51	73·5	75	144	147
1° 50′	38·5	54	56·5	140	147
2° 20′	26·5	38	40	143	151
3° 20′	17	23·6	25	139	147
4° 20′	12	16·8	18	140	150
5° 15′	8·9	12	13·5	135	152
6° 15′	7·5	10	12·3	133	164
6° 55′	5·1	6·8	7·7	133	151
7° 55′	4·4	5·8	6·5	132	148
8° 50′	3·7	4·8	5·5	130	149
10° 45′	2·95	3·85	4·5	130	152
12° 45′	2·5	3·28	3·85	131	154
14° 45′	2·1	2·75	3·2	131	152
16° 45′	1·7	2·3	2·65	135	156
			Mean observed %	135·5	151
			Calculated %	140	148

For high orders of reflexion the values of T_0 should, in some cases, be well within the limits of observation. Experiments are in progress to test this point.

Quantitative measurements of the temperature variation of the intensity of diffuse reflexion are not easy to make, but such measurements have already been provided by Laval[2] for the 002 and 004 scattering regions of potassium chloride at temperatures 290° K., 550° ± 10° K. and 665° ± 15° K. In Table 2 his data are given, first on an absolute scale, then with the high-temperature measurements expressed as a percentage of those at room temperatures; and finally his mean results are compared with those calculated from the expression

$$\sigma_B \propto T \,.\, e^{-T(h_1^2+h_2^2+h_3^2)/13670}.$$

The parameter ψ is a measure of the distance of the diffusely reflecting region studied, from the appropriate Bragg reflecting point.

The agreement is well within the limits of the (10 per cent) experimental accuracy claimed by Laval. Moreover, the comparative constancy of $\sigma_T/\sigma_{290° \text{K}}$. for different values of ψ (corresponding to a range of elastic wave-length 90 → 16·5 A. for 002, and 127 → 10·7 A. for 004) shows that it is legitimate to assume constancy of intensity distribution with change of temperature.

Laval himself did not realize how well his results confirmed the predictions of the thermal theory, and it is perhaps the more remarkable that he should have concluded his experimental study with the words "On peut espérer que la topographie des domaines de la diffusion forte apportera des renseignements précis sur la distribution de l'énergie entre les diverses ondes élastiques qui constituent l'agitation thermique."

M. Born.
University, Edinburgh.
K. Lonsdale.
Royal Institution, London.

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[1] Sarginson, K., *Proc. Roy. Soc.*, A, **180**, 305 (1942).

[2] Laval, J., *Bull. Soc. Franç. Min.*, **62**, 137 (1939).

Vitamin P in Blackcurrants

The necessity for finding sources of ascorbic acid other than citrus fruits has turned increased attention to the utilization of fruits produced in Great Britain and at the present time both wild and cultivated fruits are being studied in some detail. It is accordingly of interest to note that while blackcurrants, like the citrus fruits, provide a rich source of ascorbic acid, they have now been found to contain considerable quantities of the factor known as vitamin P which has hitherto been mainly derived from citrus fruits. The fraction showing vitamin P activity may most conveniently be isolated from blackcurrants by extracting the depectinized and concentrated juice with amyl alcohol. After the removal of the anthocyanins by extraction of the amyl alcohol solution with dilute hydrochloric acid, the material may be further purified by precipitating the active fraction from ethyl alcoholic solution as the lead salt by a method which is essentially that described by Szent Györgyi[1] for the preparation of 'citrin'. Decomposition of the lead salt gives a red-brown material which has not yet been obtained crystalline; it is soluble in water and appears to consist largely of glycosides of anthoxanthin type. The material has been isolated in a yield corresponding to 0·03 per cent of the original juice.

Biological tests have been carried out on this material by Mr. A. L. Bacharach in the Biochemical Department of Glaxo Laboratories, Ltd., by a method recently described[2], and it has been found that the material has an activity 100 times greater than that of recrystallized hesperidin and 10 times greater than hat of a water-soluble 'citrin' preparation derived from oranges. The blackcurrant product therefore provides a source of vitamin P in a relatively concentrated form suitable for further chemical study.

The hips of wild rose species, such as are now also being used extensively for the preparation of ascorbic acid concentrates, were shown as a result of biological tests by Zacho[3] to contain vitamin P. Preparations made from rose hips in this laboratory by methods imilar to that described above have been found to ontain a fraction resembling the blackcurrant material in its chemical behaviour.

A. Pollard.

University of Bristol,
Agricultural and Horticultural
Research Station,
Long Ashton, Bristol.

[1] Szent-Györgyi, A., *Z. physiol. Chem.*, **255**, 126 (1938).

Bacharach, A. L., Coates, M. E., Middleton, T. R., *Biochem. J.*, **36**, 407 (1942).

[3] Zacho, C. E., *Acta path. microbiol. Scand.*, **16**, 144 (1939).

Vitamin C in the Days of Francis Bacon

In recent years the history of the deficiency diseases, caused by lack of the substances which we now call vitamins, has been carried back further into the past by various discoveries in the older literature of science and medicine[1]. In the published results of these historical inquiries I have not seen any allusion to the following remarkable passage in the "New Atlantis" of Francis Bacon which was written about 624.

> "We sailed from Peru . . . by the South Sea, taking with us victuals for twelve months and had good winds from the east, though soft and weak, for five months' space and more. . . ." When they at last sighted New Atlantis ". . . our sick, they were many, and in very ill case, so that if they were not permitted to land, they ran in danger of their lives . . . we were in all, sick and whole, one and fifty persons, whereof our sick were seventeen." One of the inhabitants of the island came aboard "holding in his hand a fruit of that country, like an orange, but of colour between orange-tawny and scarlet, which casts a most excellent odour: he used it, as it seemeth, for a preservative against infection." After the authorities had given permission to land "there were brought in to us great store of those scarlet oranges for our sick, which, they said, were an assured remedy for sickness taken at sea." During the next three days "we had every hour joy of the amendment of our sick, who thought themselves cast into some divine pool of healing, they mended so kindly and so fast."

The "New Atlantis" is, of course, fiction, a short 'novel with a purpose' in fact, and cannot be adduced as direct evidence of the scientific knowledge of the time. But this narrative of a large part of a ship's crew incapacitated by illness after a voyage of five months, and the rapid recovery of the sick men when fresh fruit was obtained, corresponds so closely to the picture of an outbreak of scurvy, counteracted at once by a supply of vitamin C, that it is very unlikely to have been an invention. Harris[2] says, ". . . in the ships of the East India Company, oranges or lemons or lemon juice had been used regularly as antiscorbutics from 1601 onward: they had been introduced into the Company at the instigation of Sir James Lancaster, who had demonstrated their value on his 'privateering expeditions'." This practice is probably the source of Bacon's information, and his allusion to this subject in the "New Atlantis" illustrates the width of his knowledge.

E. L. Kennaway.

Chester Beatty Research Institute,
Royal Cancer Hospital (Free),
London, S.W.3.
Oct. 6.

[1] Harris, L. J., "Vitamins and Vitamin Deficiencies", 1, 3–21 (1938).

[2] *loc. cit.*, 4.

Mechanism of Sensitivity Changes of Sense Organs

It is at present an established fact that the dark-adapted eye alters its sensitivity when acoustic stimuli are applied to the ear (Lazarev, Kravkov and others) or when olfactory stimuli act upon the olfactory organ (Makarov), etc. We have succeeded in showing that similar changes, either towards increase or decrease of eye sensitivity, are caused by taste stimuli (sweet, acid, salt or bitter) as well as by temperature (cold or heat) and tactile stimuli.

However, the eye is influenced not only by stimulation of extero-receptors (external organs of sense). Regular shifts of thresholds of peripheral vision have been produced by changing the volume of the stomach or of the urinary bladder by means of tepid water or physiological saline. Finally, a similar effect was elicited by the extension of articular capsules of muscle tendons and of muscles themselves. Thus stimulation of extero-, intero- and proprioceptors always results in change of sensitivity of dark-adapted eye. In other words, sufficiently strong stimulus applied to any area of receptive field of the human organism immediately affects functional properties of the eye. There is experimental evidence to show that the eye is no exception in this respect, and that all organs of sense of man undergo some changes in sensitivity upon excitation of any other organ of sense (interaction of afferent systems).

It was suggested several years ago by L. A. Orbeli from his own morphological and physiological evidence that an increase or decrease of sensitivity of receptors is due to the vegetative nervous system. This hypothesis has been checked by means of the above method.

First of all, parallel records were made in one of a series of experiments on thresholds of the dark-adapted eye, of frequency of pulse, and of electrical resistance of skin to constant current during and after excitation of various organs of sense (taste and temperature receptors). It was found that decrease of thresholds of peripheral vision is almost always accompanied by acceleration of pulse and change in skin resistance. The last-mentioned two functions are well known to be controlled by the vegetative nervous system.

In another series of experiments, the olfactory receptor of subjects was stimulated by sympathomimetic (geraniol) and parasympathomimetic (thymol) olfactory agents. In the first case sensitivity of eye as well as pulse frequency underwent increase, while in the second case the effect was opposite in character.

Finally, in a third series of experiments, use was made of the so-called vegetative tests (Anshner-Danini, Abrams, Luga, and others). It is a well-known fact that pressure exerted on the eyeball, palatum durum or the vertebra invariably causes change in pulse frequency. According to our expectations, change was also noted in the sensitivity of a dark-adapted eye, the two series of changes showing parallel courses.

Thus it will be concluded that change in sensitivity of the eye is effected by the vegetative nervous system in accordance with Orbeli's hypothesis. Change in functional properties of one organ of sense caused by stimulation of another sense organ is therefore to be regarded as a senso-sensory vegetative reflex, which in its turn is part of a diffuse reflex of the vegetative nervous system involving also the heart (senso-cardial reflex) and skin (senso-cutaneous reflex), as well as other organs and systems of the human body. KRIKOR KEKCHEEV.

Soviet Scientist Antifascist Committee,
Moscow. (Recd. by cable, Oct.12)

Glucose-Excretion by the Rabbit Kidney

WORK carried out in this laboratory has proved[1] that the glucose threshold in the rabbit kidney is stabilized in the neighbourhood of a plasma concentration (C_b) of 240 mgm. per 100 mil. plasma (mgm. per cent) when the animal is under the influence of urethane. In a few rabbits the threshold level under urethane was higher than 300 mgm. per cent, but the bulk of the observations fell between 200 and 260, with a marked modal peak at 240 mgm. per cent. Large doses of insulin—approximately 10 units/kgm.—had a doubtful effect on the urethane threshold level, depressing the mean threshold from 282 to 243, which is not a significant change. More recent work[2] has shown that under nembutal narcosis, insulin, 1 unit/kgm., develops a marked depressant effect on the threshold level, and may indeed cause a rise in urine glucose, measured as fermentable reducing substance, at a time when C_b is falling.

It will be noted that the dose of insulin necessary to lower the threshold in the rabbit under nembutal narcosis is approximately one tenth the dose which in the urethanized rabbit produced a minimal effect. This indicates that urethane inhibits some of the effects of insulin, and the implications of this discovery are discussed in a recent publication[2].

Adrenalin causes a marked rise of threshold in the rabbit both under urethane and nembutal narcosis[2]. The threshold in the unanæsthetized rabbit is in the neighbourhood of $C_b = 120$ mgm. per cent. Unpublished results on normal young men show that the insulin effect may be elicited sometimes. The adrenalin effect has been shown to occur in renal glycosuria.

The investigation is continuing.

T. W. T. DILLON.

Dept. Materia Medica and Therapeutics,
University College,
Dublin. Oct. 5.

[1] Dillon and O'Donnell, *Proc. Roy. Irish Acad.*, **42**, B, 14, 365.

[2] Dillon and Feric, *Proc. Roy. Irish Acad.*, **47**, B, 7, 179.

Records of Lancashire Cetacea

As records of Lancashire cetaceans are few, I thought it worth recording that when told of a 'big porpoise' washed up on the west Lancashire coast at Birkdale, Southport, on September 23, 1942, I identified it as a young male bottle-nosed dolphin (*Tursiops truncatus* Montagu) and took the following measurements: length 105 in., flippers 14 in., tail flukes 21 in. across, girth of body 50 in., depth of body 22 in., 'bottle nose' extension of upper jaw 5 in., 22 pairs of teeth in upper jaw, and probably same in lower but a few were removed by souvenir-hunters. Upper parts black, also flippers; underparts pale grey. The only previous Lancashire record I can trace was a specimen stranded at Walney Island on August 8, 1917[1].

On December 10, 1939, when a reported 'killer whale' was stranded alive by the flood tide on the Mersey bridge pontoons at Widnes, I was surprised to find that no one had gone to investigate it, and when I got there it had been cut up and returned to the river, but I obtained sufficient press photographs to identify it as Risso's grampus (*Grampus griseus* and sent a photographic print to the Liverpool Museum, which was later sent to the British Museum I also obtained a film strip of Leica negative of various positions of the specimen and sent this in to Liverpool Museum to authenticate the record, but unfortunately a year later, when the Museum was burned in an air raid, these negatives had not been developed and they were lost in the fire. Measurements and details I secured at the time from those who killed the specimen at Widnes, and from the photographs were: length 11½ ft., no teeth in upper jaw, a few teeth in lower jaw ¾ in. apart and blunt; body marbled and streaked with greyish-white, underpart smooth; long, narrow, white flippers; tail fluke long and narrow; dorsal fin tall; white about the muzzle; lower jaw shorter than upper jaw. Total weight about two hundredweights. It was alive an 'blowing' when caught by the men. A recognizabl photograph appeared in the *Liverpool Post* and othe local papers. There is no previous Lancashire record but in the north-west area one was recorded at Bardsey in 1933 and there is a much older Solwa record. ERIC HARDY.

British Empire Naturalists' Association,
(Merseyside Branch),
47 Woodsorrel Road, Liverpool, 15.

[1] Booth, *Naturalist*, 300 (1917).

FRESHWATER FISHES

THE work of the Freshwater Biological Association of the British Empire shows a large amount of activity on the part of all workers*. Naturally research on fishes takes the lead and much that is of real economic importance has been achieved. Of outstanding interest is the successful commercial perch fishery on Lake Windermere. This is an excellent example of a practical application in war-time of research carried out previously with purely scientific motives (see NATURE, 148, 651; 1941). Work on the study of the perch in Windermere was begun in 1933–35 by Mr. K. R. Allen who demonstrated by the use of traps that perch migrate into the shallows in spring. This resulted later in large-scale use of traps in catching perch by the ton with little labour and on a commercial scale. A firm of canners has now marketed the canned fish as 'Perchines' which have had a very favourable reception, and from the financial point of view also the project was a success. Traps were tried on other lakes which gave good results and the Ministry of Agriculture and Fisheries has decided to organize fisheries similar to that on Windermere on six lakes, two more being arranged by private enterprise. It is possible that in some of the lakes other fish, such as eels and pike, which enter the traps in pursuit of the perch, may be an even more valuable catch. The possibility of expanding the industry to water outside the Lake District is now being explored. It is expected that the rod fisheries will be improved by the reduction in number of perch, pike and eels. In Windermere the examination of changes in the flora and fauna due to the reduction in perch is being undertaken.

Since the beginning of the War the Association, in co-operation with the Ministry of Agriculture and Fisheries, has devoted much attention to the fact hat British waters could, and should, produce all he eels imported from the Continent during times of peace, and many more besides. Experiments were begun in 1941 in connexion with eel-fishery, on the use of artificial light for deflecting silver eels into traps. Although so far they are not conclusive it was confirmed that silver eels react to light more or ess in the way expected, and that there are no erious practical difficulties, even in war-time, in the way of rigging lights to be seen under water by migrating eels. With one of these systems of lighting bout half the eels from both natural and artificial runs swimming down one side of the stream were deflected to the other side. It was also found during hese experiments, by the use of traps divided horizontally, that about one third of the eels were swimming nearer the surface than the bottom. As is generally assumed that the migrating fish swim lose to or along the bottom of rivers, this fact may e important when reconsidering the design of ommercial traps.

Miss Winifred Frost has been working on various shes and has advanced steadily our knowledge of he freshwater life of British eels. Drainage basin vers ascending the rivers in spring, yellow eels habiting the lakes, and silver eels descending to he sea in autumn have all been examined. Otoliths nd scales were used, although these are not truly tisfactory for age growth determination in eels bove 40 cm. in length. The results show that all the silver eels and the great majority of yellow eels examined were female: presumably nearly all males live in or near the estuaries. About eight years of freshwater life takes place before the eels attain a length of 40 mm. and a weight of ¼ lb. After that the growth varies widely until the fishes migrate to the sea as silver eels after 10–17 years of freshwater life. The silver eels range in length from 47 cm. to 94 cm. and in weight from 7 oz. to 4 lb. Many of the eels examined for food contained molluscs, fishes and insects. Molluscs were common in the yellow eels, which also contained minnows, perch and caddis larvæ. Some of the silver eels contained perch, minnows and caddis flies. Elvers taken from the River Leven just after their entrance into freshwater were feeding heavily on chironomid larvæ—a common food of the trout.

Miss Frost's work on minnows shows that they are important competitors for food with young perch and trout, while although the char and the young perch are both plankton feeders they usually eat different species.

Artificial fertilization of char eggs and rearing of fry are being carried out at Wragmere fish hatchery. The fry are reared more easily than the trout until the complete absorption of the yolk, but after that they present difficulties in the fry ponds. It is hoped to rear the fry in boxes in the lake where natural plankton food will be available. Growth-rate and feeding habits in the trout from different localities are being studied and successful cross fertilizations have been made between brown trout, Windermere char and the American brook trout or char.

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* Tenth Annual Report for the Year ending 31st March, 1942. mbleside: Freshwater Biological Association of the British Empire.) 40. 1s. 6d.

RADIO RESEARCH

IN his inaugural address as chairman of the Wireless Section of the Institution of Electrical Engineers, delivered on October 7, Dr. R. L. Smith-Rose dealt first with the history and growth of the Wireless Section, then with the work of the Radio Research Board; and finally he presented a survey of the present state of our knowledge of the speed of travel of electric waves of all wave-lengths from the visual to the radio-frequency spectrum (the substance of this last section appears on p. 477).

The Wireless Section of the Institution is just over twenty-three years old, in which time its membership has grown to more than eleven hundred. The Section has held 163 formal meetings, at which addresses and papers have been delivered, while informal meetings have been arranged from time to time to discuss topical technical subjects. In 1926 a report presented to the Council of the Institution by the committee of the Wireless Section referred to a proposal which was then being mooted in some quarters to form a new Institute of Wireless Engineers. The report suggested that such a step was unnecessary and would not be supported by representative and qualified wireless engineers. It was explained that an engineer with adequate wireless qualifications could become a corporate member of the Institution, and that other wireless engineers not reaching that standard were eligible as graduates, and as such could attend all meetings of the Wireless Section as well as of the Institution. Furthermore, the committee recommended that while it was essential that the standard of qualifications for membership of the Institution should be maintained, more opportunity should be afforded to the physicist engaged in wireless work to become a member of the Institution. This recommendation was approved by the Council and has continuously been acted upon by the committees responsible for electing new members; it is particularly opportune to direct attention to it at the present time, when a large number of men engaged on wireless work would probably refer to themselves as radio physicists rather than wireless or radio engineers.

Among other recommendations made in the report referred to above was one to the effect that all papers and discussions of a wireless nature should be published in a separate *Proceedings of the Wireless Section* as well as in the *Journal* of the Institution. For this every member of the Wireless Section must be very grateful. Fifteen volumes of these *Proceedings* were published during the period 1926–40, and these contain a most valuable record of the progress of wireless engineering research and development in a very compact form and free from the large mass of other papers published by the Institution and in which the wireless engineer has little more than general or passing interest. With the revision of the form of the *Journal*, which was necessitated by paper shortage considerations in 1940, the existence of these *Proceedings* formed a most valuable precedent for ensuring that papers on wireless were still published separately as Part III of the present-day *Journal*. It is very clear that as regards the provision of scope and opportunities for publication, no separate society or association could serve its members better than the Institution has done during the past sixteen years and still continues to do in a very satisfactory manner.

Dr. Smith-Rose next referred to the work of the Radio Research Board, with which he has been associated since its establishment in 1920 under the Department of Scientific and Industrial Research. Although concerned mainly with investigations of a fundamental nature, many of the aspects of the Board's programme are determined from time to time by the needs of the defence departments and of the Post Office and B.B.C., each of which has been represented on the Board itself and on all its technical committees. The Board makes its recommendations to the Department of Scientific and Industrial Research, which is responsible for providing the means and facilities for the conduct of the work; in recent years practically the whole programme has been entrusted to the Radio Department of the National Physical Laboratory for execution. Apart from the official reports of the Radio Research Board issued from time to time, the majority of the investigation work has been described in papers and reports published by the Institution of Electrical Engineers and other scientific societies. As an indication of the widespread nature of this publication it may be pointed out that of the 246 papers that have been published in the *Proceedings of the Wireless Section* during the past sixteen years, no less than eighty of them have been presented by staff working under the auspices of the Radio Research Board.

Little can be said about the recent investigations in hand, since for the past three years the work has been devoted entirely to the furtherance of the prosecution of the radio technical war in the manner in which is considered to be most useful. A conspicuous feature of this recent work has been to realize the fruition in direct Service application of all the long-term investigations sponsored for many years past by the Radio Research Board. The present value of pre-war fundamental work on direction-finding and ultra-short-wave propagation, suitably oriented to meet present conditions, is immediately obvious; but by now most of the apparently more academic subjects under investigation have suddenly been elevated to Service applications of the highest priority. Even some of the research items which had been abandoned in the past as having little or no interest have had to be revived to meet pressing demands, and it is often the fact of having already explored the technique and satisfactorily established the fundamental principles of a particular field that provides the advantage over the enemy in the technical conduct of the war. In some spheres the demand is for basic principles of design of apparatus and equipment which was developed originally as a research tool, and now has to be adapted to more practical application; in other spheres it is accurate measuring equipment and technique that is sought; while in yet other directions the request is for information that will define the present possibilities of radio communication, and more especially what these are likely to be in the immediate future.

AUSTRALIAN ASSOCIATION OF SCIENTIFIC WORKERS

THE Australian Association of Scientific Worker called two conferences of scientific workers—one in Sydney on February 21–22, and one in Melbourne on March 7–8—to consider the use being made of scientific men in Australia in furthering the wa effort.

The Melbourne Conference was attended by about one hundred and thirty members. Industrial undertakings and Government enterprises were almos equally represented; the younger members were in great majority. There was apparent a certain restraint in expressing views, possibly due in part, a least, to the more senior members not giving a lead There was no doubt at all of the sincere wish to giv all services required, but there was apparent dee misgivings whether the Government understood an appreciated what could be done—and can be done—by scientifically trained people given problems t solve; indeed, the opinion was expressed that the scientific men themselves had a duty (1) in seeing fo themselves what problems needing immediate solution already existed, (2) in anticipating problems tha would inevitably arise, and (3) in suggesting method of solution and carrying them out. But the doub was raised whether the Government has confidenc in scientific men, or whether it is just a lack of understanding on the part of the scientific men of politic methods.

Among the more important problems discusse were: lack of understanding of industrial fatigue absence of suitable bodies to study this problem factories; the inability to make use of experienc gained elsewhere; lack of foresight in planning fo supplies, especially in agriculture, and in poolin information of plant practices; the wastage scientifically trained man-power in the Fightin Forces.

It was stated that little or no use is being mad of the professional registers; and that the examin tion of inventions is neglected in many cases. Waste and by-products useful in certain industries are being neglected, while other industries could put many of them to good use, and have, in fact, been wanting some of these products. There appeared to be lack of co-ordination of efforts in industries engaged on similar work.

In short, problems which have been engaging the attention of scientific men in Great Britain, and many of which have been solved, are being experienced in Australia also.

The results of the debates were crystallized in ten resolutions which are now being communicated to the appropriate authorities. It is hoped that action will be taken by the Government. The Australian Association of Scientific Workers proposes to watch developments, and will make use of its special knowledge to see that better use is made of Australian scientific resources and man-power.

PACIFIC RELATIONS IN THE POST-WAR WORLD

THE second of the series of reports on the United States in a new world, based on the findings of a committee of the editors of *Time*, *Life* and *Fortune* set up to study post-war problems, is of particular interest as indicating the trend of advanced American thought on Pacific relations. The proposals are based on a belief in the greatness of Asia, and on the view that progress towards free and more abundant life in times of peace must be mainly concerned with a practical solution of the problems of productivity, literacy and common law and order, and that the East needs the social inventions of the West just as much as its technology. It is assumed that in the largest degree the peoples of Asia must work out their own solution, and the preference for strong and effective international authority is clearly indicated; although it is recognized that the United States may, in certain circumstances, have to be the principal trustee of the United Nations, while others are growing into modernity or recovering from the consequences of the War. The report proposes an organization to be called the Pacific Council, which would be the final judicial authority of the United Nations on Pacific affairs, although for the co-operative international administration required in specific jobs, the organization of special co-operative bodies is suggested, representing only those members of the United Nations which have a legitimate interest in the specific tasks.

The first of these tasks proposed is that of creating a nation in South-Eastern Asia. Coupled with an independent Philippines, it is suggested that new States should be created out of the other ex-colonies of Indonesia. The first and largest of these States would consist of Thailand, British Malaya, all the British and Dutch Islands in Indonesia and Portuguese Timor, with the political status of an international republic, in which it is suggested the ability and responsibility of the Dutch Colonial administrators will find ample scope. For the creation of this State the ultimate reasons are military and economic. In regard to Burma, it is suggested that Great Britain should transfer its rights to an international commission, on which Great Britain, India, China and the United States would be strongly represented, which would conclude an agreement with China concerning its transit rights on the Burmese roads, railways and rivers, and in the port of Rangoon. The first task of this commission would be that of physical reconstruction. It is suggested that France might be induced to agree to a similar course for Indo-China, after the preliminary restoration of French sovereignty.

While long-term control and disarmament of Japan is not considered feasible, it is suggested that if an American-Chinese-British-Dutch Group took over the Japanese aviation monopoly and its installations under a contract to run for 25–50 years, its operation would preclude any effective secret Japanese rearmament. Transfer of Japanese investments in Manchuria and China to China is suggested, and control of Japan's merchant marine should be vested in a Combined Shipping Board. The best hope for a change of heart in Japan is regarded as lying in the total discrediting of its military leaders and their followers, and in a resulting resolve of the Japanese people themselves to oust them.

With regard to China, the more serious specific problems to be solved are those of agriculture, industrialization, the restoration of an economic industrial balance, transport and education. All these principal problems are interrelated and formidable, but the building of a strong and free China is a Chinese task. The interdependence of China and other nations including the United States is recognized, however, and industrialization can only come naturally as part of a general international expansion if China is certain that such international economic expansion will occur, as expansion depends fundamentally on American participation. The approach to post-war economic relations can only be freed from mutual suspicion by a better understanding of the facts. The Chinese problem is to secure the essential financial and technical assistance from abroad, without paying for it through impaired sovereignty or the loss of control over national resources. The report strongly supports the participation in a free market area open to every nation, and Chinese exports should not be debarred from American markets by high duties. Economic relations with China require the admission of Chinese goods in payment of Chinese obligations, and the cheap imports would benefit the general United States public.

The danger to American industry and standards of living is discounted, and it is considered that one article of the mutual aid agreement should keep Asiatic, and especially Chinese, protectionism within bounds. These are the general principles for future and long-range application, and immediate measures should be taken with these objects in view. Reconstruction grants on a minor scale should greatly assist co-operation in the field of higher education, and the services of highly skilled scientific men and technicians are likely to be in very high demand in post-war China. The report frankly faces the changes in the American immigration law, which, like changes in the tariff, will be required. Leading problems of Korea, India, the South Pacific and New Zealand are briefly reviewed, and while the idea of a Pacific counterpart of the Atlantic Charter is discounted, the importance of establishing cordial confidence as a basis of unity and high morale in the United Nations is emphasized.

OTOLOGY AND FOLKLORE

IN a recent paper (*J. Laryng. and Otol.*, 57, 311; 1942) on this subject, Dr. J. D. Rolleston stated that though Toynbee is generally acknowledged to be the founder of modern otology, the first recognition of ear disease can be traced back to the Ebers papyrus, which contains a monograph on "ears hard of hearing" and on "ears from which there was a putrid discharge". Although there is an enormous amount of literature connected with the history of otology, the only comprehensive study of the folklore of this speciality is that furnished by Hovorka and Kronfeld in their treatise on comparative folk-medicine.

Among the numerous popular beliefs and superstitions connected with the ear, the most interesting to folklorists and students of the history of religions is the idea of the ear serving as the female organ of generation, particularly in the conception of Jesus, which was supposed to be effected by introduction into the Virgin Mary's ear of the breath of the Holy Ghost. Belief in this unusual function of the ear, which was often illustrated by medieval artists, is not peculiar to Christian mythology; it is also found in Mongolian, Persian and Indian legends. A belief in a relation between the size or shape of the external ear and the character of the individual was widespread, small ears being a sign of mental power, large ears indicating dullness, and pointed ears a bad character.

The belief that tingling of the ear is a sign that others are speaking of you dates back to the time of Pliny, who stated that this was then a universally accepted notion.

A belief once prevalent in the north-east of Scotland was that deaf mutes possessed the faculty of looking into the future and discovering what was hidden to others.

In accordance with the rule that prophylaxis is much rarer in folklore medicine than curative measures, there are comparatively few instances of preventive measures employed against ear disease, and, such as they are, consist mainly of amulets. Therapeutic treatment, on the other hand, was abundant, and can be classified under the headings of animal remedies, including coprotherapy, plant remedies, mineral remedies, hydrotherapy, invocation of patron saints and miscellaneous remedies.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk are open to the public*)

Monday, October 26

ROYAL INSTITUTE OF PUBLIC HEALTH AND HYGIENE (at 28 Portland Place, London, W.1), at 3 p.m.—Prof. J. C. Drummond: "The Background to the Study of Nutrition in War-Time" (Harben Lectures, 1).*

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Miss Mildred Cable: "A New Era in the Gobi".

Tuesday, October 27

ROYAL INSTITUTE OF PUBLIC HEALTH AND HYGIENE (at 28 Portland Place, London, W.1), at 3 p.m.—Prof. J. C. Drummond: "Deficiency Conditions to be guarded against in War-Time" (Harben Lectures, 2).*

Wednesday, October 28

ROYAL INSTITUTE OF PUBLIC HEALTH AND HYGIENE (at 28 Portland Place, London, W.1), at 3 p.m.—Prof. J. C. Drummond: "Measures taken to Maintain a Good Nutritional Condition of the People in War-Time" (Harben Lectures, 3).*

Thursday, October 29

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 2.15 p.m.—Mr. T. Besterman: "A Projected Bibliography of Dictionaries"; Mr. S. J. Astbury: "The Bibliography of Petroleum".

Friday, October 30

LISTER INSTITUTE OF PREVENTIVE MEDICINE (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 3 p.m.—Prof. P. A. Buxton: "Bacot's Work on the Louse and some of its Recent Developments" (First Bacot Memorial Lecture).*

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, Hampstead, London, N.W.3), at 8 p.m.—Dr. K. Mendelssohn: "Temperatures near Absolute Zero".*

Saturday, October 31

INSTITUTE OF PHYSICS (ELECTRONICS GROUP AND MIDLAND BRANCH) (at the College of Technology, Rugby), at 2.45 p.m.—Dr. D. Gabor: "Electron Optics".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MASTER TO TAKE MATHEMATICS, ENGINEERING DRAWING, AND ENGINEERING SCIENCE—The Principal, Enfield Technical College, Queensway, Enfield, Middlesex (October 30).

LECTURER IN ENGINEERING—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (October 31).

GRADUATE OR NON-GRADUATE TEACHER OF ENGINEERING SUBJECTS, INCLUDING WORKSHOP INSTRUCTION, at the Grimsby Technical College—The Director of Education, Education Offices, Eleanor Street, Grimsby (October 31).

LECTURER IN MECHANICAL OR ELECTRICAL ENGINEERING—The Registrar, Loughborough College, Loughborough, Leics. (October 31).

LECTURER IN CHEMISTRY at the Technical College, Cardiff—The Director of Education, City Hall, Cardiff (November 1).

TEACHER IN THE ENGINEERING DEPARTMENT—The Principal, Municipal Technical College, Halifax (November 2).

TEACHER TO GIVE INSTRUCTION IN THE ENGINEERING WORKSHOPS—The Principal, Municipal Technical College, Halifax (November 2).

CHIEF ASSISTANT ENGINEER—The General Manager, Port of Bristol Authority, Docks Office, Queen Square, Bristol 1 (endorsed 'Chief Assistant Engineer') (November 7).

TWO INSTRUCTORS FOR DAY CLASSES FOR TRAINING OF MARINE ENGINEERS, at the Stow College, School of Engineering—The Director of Education, 129 Bath Street, Glasgow, C.2 (November 20).

LECTURER FOR THE ENGINEERING DEPARTMENT of the Stockport College for Further Education—The Director of Education, Education Offices, Town Hall, Stockport.

LECTURESHIP IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Central Technical College, Suffolk Street, Birmingham 1.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 12: Seaweed (*Laminaria*) as Stock Food. By Prof. E. J. Sheehy and J. Brophy and Prof. T. Dillon and P. O'Muineachain. Pp. 150–161. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s*. [249

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 3: Atmospheric Pollution in Dublin during the Year 1941. By A. G. G. Leonard, Bridget P. McVerry and D. Crowley. Pp. 10–17. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s*. [249

British Rubber Producers' Research Association. Publication No. 23: The Phosphatides of *Hevea brasiliensis*. By G. R. Tristram. Pp. 8. (London: British Rubber Producers' Research Association.) [259

Edinburgh and East of Scotland College of Agriculture. Calendar for 1942–1943. Pp. 64. (Edinburgh: Edinburgh and East of Scotland College of Agriculture.) [710

Proceedings of the Royal Society of Edinburgh, Section B: Biology. Vol. 61, Part 3, No. 23: Types of Development of Polytene Chromosomes. By Dr. A. M. Melland. Pp. 316–327+1 plate. (Edinburgh and London: Oliver and Boyd.) 1*s*. 3*d*. [710

Other Countries

Report of His Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty for the year 1941. Pp. 7. (Cape of Good Hope: Royal Observatory.) [23

Indian Central Cotton Committee: Technological Laboratory. Technological Research on Cotton in India: being an Account of th Work done at the Indian Central Cotton Committee Technologica Laboratory, 1924–1941. By Dr. Nazir Ahmad. Pp. xi+182+12 plates (Bombay: Indian Central Cotton Committee.) 2.8 rupees. [23

Indian Forest Records (New Series). Entomology, Vol. 7, No. 1 On the Biology of the Parasites of the Shisham Defoliators in th Punjab Plantations. By R. N. Mathur, with a Note by C. F. C. Beeson. Pp. iii+65. (Delhi: Manager of Publications.) 2 rupees 3*s*. [71

Smithsonian Miscellaneous Collections. Vol. 101, No. 18: A New Species of Sand Bug, *Blepharipoda doelloi*, from Argentina. By Wald L. Schmitt. (Publication 3687.) Pp. 10+1 plate. (Washington, D.C. Smithsonian Institution.) [71

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A CENTRAL PLANNING AUTHORITY

WHEN the Uthwatt Committee issued its interim report in July of last year, Lord Reith announced that all necessary preliminary steps towards the working out of a national plan of reconstruction and development should be taken as soon as possible. The Committee itself based its interim recommendations on the assumptions that a central planning authority would be established without delay and would proceed with the working out of a national plan. The final report of the Committee, published a few weeks ago, shows clearly that it proceeded with its work in this conviction, reached at an early stage in the inquiry, that a central planning authority with a positive policy for such matters as town and country planning, agriculture, industrial development and transport is essential to an effective physical reconstruction of Great Britain after the War. That case is put with admirable firmness and lucidity in the final report. Yet, as Lord Reith pointed out in initiating a debate on the subject in the House of Lords on October 22, the Government has contented itself with a statement of general approval only. Something more is needed at once. Lord Reith pressed for the immediate creation of machinery for national planning under a Minister of National Development. This proposal is an advance on the position taken up by Lord Reith early this year while he held office as Minister of Planning, and he explained that his earlier statement represented all he could obtain at the time.

The final report of the Uthwatt Committee takes its place with those of the Scott Committee (see NATURE of October 17, p. 441) and of the Barlow Commission in completing the survey of the steps to be taken to prevent the work of reconstruction in Great Britain from being prejudiced by haphazard development or by the misuse of land. In many respects the Uthwatt Report is more technical and specialized than the other two, and goes very thoroughly into details which the layman may find it difficult to grasp. None the less, the general principles and recommendations are presented with remarkable lucidity, and its cogent arguments should be followed by all without difficulty.

The report opens with a quotation from the first report of the Scott Committee appointed towards the close of the 1914–18 War, which illustrates the measure of the failure of the past twenty years to adapt planning policy and methods to the needs of the situation. It raises for examination the general question whether the measures of legislation designed in recent years to secure a better utilization of land resources and to lead to an amelioration of the living conditions of the people, of which the Town Planning Acts and the Housing Acts are perhaps the most important, are based on a foundation adequate to ensure their successful operation. It constitutes a warning which cannot be ignored that the many problems involved may not be capable of solution by a system of patchwork amendments of the existing code of law or piecemeal adaptation of the existing procedure, and that a fundamentally new approach to the whole problem may be inevitable to find a satisfactory basis for any adequate measures of reconstruction and post-war planning.

The Uthwatt Committee is clearly concerned, as Mr. George Hicks told the House of Commons last year, with problems which go to the root of our economic life. Historically, its terms of reference arise out of the evidence placed before the Barlow Commission, that "the difficulties that are encountered by planning authorities under the existing system of compensation and betterment are so great as seriously to hamper the progress of planning throughout the country". These difficulties, already acute in peace-time, are now thrown into sharper relief by the effects of the War, and the leisurely trend of opinion in favour of a securer basis for planning has become an urge for action. The emphasis on reconstruction, not only as an immediate necessity for repairing the devastation caused by the War, but also as a long-term measure, has led the Committee to consider in broad outline, as its first duty, the general requirements of post-war reconstruction and the scope and object of planning.

In regard to the first, replacement of buildings destroyed during the War is popularly regarded as the main objective; but where large areas have been laid waste, they may well need to be replanned in the light of modern requirements, and this cannot be done in isolation. It must form part of a long-term policy for the town or city concerned, and for adjoining areas. Moreover, there are innumerable areas in many towns and cities which urgently need modernizing to meet present-day requirements, and the complete reconstruction of such areas is as important as the rebuilding of war-devastated areas; the two tasks should be regarded as different parts of a single problem.

This, however, is only a small part of the picture. The requirements of agriculture, the location and re-establishment of industry for peace-time production, the elimination of congestion from built-up areas, the building of adequate housing accommodation, the provision of open spaces, green belts and other amenities, the development and concentration of public utility services, the overhaul of our transport and communication system, the requirements of post-war development in civil aviation, and the relation of all these matters to the demands of future defence—all these are problems which must be considered when plans for the post-war period are being formulated. It is essential to use the relatively small area available to achieve properly balanced and co-ordinated planning of the whole, as contrasted with the confused development in the past in an isolated and regional manner. The Committee's recommendations are framed, therefore, to provide a basis for whatever policy may be adopted, so that it may be freed from any elements which might hamper, prejudice or delay its effective execution.

In regard to the evolution of planning, the Committee observes that the most important general defects of the present system, under the 1932 Town and Country Planning Act, are that the planning powers are permissive only; the planning schemes are necessarily local, not national, in outlook; and the planning powers of local authorities are largely regulatory in character and do not, except to a limited degree, enable them to undertake or secure positive development. Moreover, while this planning system, handicapped by these defects and by the absence of central positive direction, is inadequate to secure the best social use of the land of Great Britain, it is also clear that the evolution of planning principles and practice has not kept pace with the economic, industrial or strategical requirements of the country. That much was clearly established by the Barlow Commission, the recommendations of which mark a turning point in the evolution of planning in Great Britain and lead naturally to the assumptions upon the positive aspects of planning on which the Uthwatt Committee bases its recommendations.

The first assumption is that national planning is intended to be a reality and a permanent feature of the administration of the internal affairs of Great Britain. It is assumed that planning will be directed towards ensuring that the best use is made of land in order to secure economic efficiency for the community and well-being for the individual, and that it will be recognized that this involves the subordination to the public good of the personal interests and wishes of landowners. Unreserved acceptance of this conception of planning is vital to a successful reconstruction policy, for every aspect of a nation's activity is ultimately dependent on land. The difficulties in regard to compensation and betterment arise fundamentally from the existing legal position with regard to the use of land, which attempts largely to preserve, in a highly developed economy, the purely individualistic approach to land ownership.

Recognizing that town and country planning is not an end in itself, but the instrument for securing that the best use is made of the available land in the interests of the community as a whole, and as such must advance with the condition of the society it is designed to serve, the Committee assumes, secondly, that the system required for effective reconstruction is one of national planning. This requires a high degree of initiative and control by the central planning authority, which will have national as well as local considerations in mind, will base its action on organized research into the social and economic aspects of the use and development of land, and will have the backing of national financial resources where necessary for a proper execution of its policy.

These assumptions should be kept in mind if we are to appreciate the spirit and logic of the report. They are implicit in the lucid analysis of the nature to existing difficulties which follows, where, in regard of undeveloped land, stress is once more laid on the importance of organized research into national requirements. Clearly, under a system of well-conceived planning, the resolution of competing claims and the allocation of land for the various requirements must proceed on the basis of selecting the most suitable land for the particular purpose, irrespective of the existing values which may be attached to individual parcels of land. To forbid building in a coastal area or a beauty spot, or because the soil is highly fertile, or to prevent some of our existing large cities from expanding further will involve sterilization from building of such land which, if unrestricted, would continue to command a high price for development. The greatest obstacle to really effective planning has unquestionably been the fear on the part of planning authorities of incurring indefinite liabilities in the matter of compensation, if the extreme step of forbidding development is taken. Compensation has, in fact, to be paid for individual loss of land values which have not been destroyed but which have only shifted to other land, and where there are a number of owners, the aggregate of values claimable by individual owners when separately assessed greatly exceeds the real loss of the claimants taken as a group.

In regard to developed land and principles of compensation, the Committee enunciates five propositions. (1) Ownership of land does not carry with it an unqualified right of user. (2) Restrictions based on the duties of neighbourliness may be imposed without involving the conception that the landowner is being deprived of any property or interest. (3) Such restrictions can be imposed without liability to pay compensation. (4) The point may be reached when the restrictions imposed extend beyond the obligations of neighbourliness. (5) At this stage the restrictions become equivalent to an expropriation of a proprietary right or interest and therefore should carry a right to compensation as such.

The main conclusions of the Committee on the problem of betterment and compensation are summarized as follows: The present statutory provisions would be altogether inadequate for application to the circumstances created by planning conceived as a national operation. The existence of the compensation-betterment problem can be traced to two root causes: the fact that land in private ownership is a marketable commodity with varying values according to location and the purposes for which it is capable of use, and that land is held by many owners whose individual interests lie in putting their own particular piece of land to the most profitable use for which they can find a market, whereas the need of the State and of the community is to ensure the best use of all land of the country irrespective of financial return. The compensation difficulty is acute in the sphere of developmental value, whether it refers to land already developed by building, as in urban areas, or to land suitable for development in the predictable future, as in fringe land around towns and cities. Development values as a whole depend on the economic factors that determine the quantum of development of various types required throughout the country, and as planning does not reduce this quantum, it does not destroy land values but merely redistributes them over a different area. In theory, compensation and betterment should therefore balance each other. In practice they do not. The present statutory code is limited in operation and is not designed to secure balance, and the Committee is convinced that within the framework of the existing system of land ownership it is not possible to devise any scheme for making the principle of balance effective. A measure of unification of existing rights in land is necessary to overcome the effect of shifting value and to eliminate the conflict between private and public interest.

The Committee stresses first that its recommendations should provide a permanent solution; secondly, that they should not be such as to result in the taking over of property by the State without fair compensation; thirdly, that they should, so far as possible, be capable of immediate adoption, be administratively practicable and not entail greater financial operations than are likely to be feasible during the War or in the early post-war period; and lastly, that they should not be such as to interfere unduly with the economic life of the country or with individual enterprise. On this basis the idea of unification by private pooling schemes or by nationalization is rejected. Instead, the Committee recommends the immediate vesting in the State of the rights of development in all land lying outside built-up areas (subject to certain exceptions) on payment of fair compensation, such vesting to be secured by the imposition of a prohibition against development otherwise than with the consent of the State, accompanied by the grant of compulsory powers of acquiring the land itself when wanted for public purposes or approved private development. As regards built-up areas, it is recommended that public authorities be given powers of purchase much wider and simpler in operation than under existing legislation. Further, a scheme for the imposition of a periodic levy on increases in annual site value, with the object of securing such betterment for the community, as and when it is realized, is suggested.

These recommendations, taken as a whole, form a scheme which is considered workable. They are accompanied by other recommendations relating to the provision of new procedure and simplifications in existing procedure for obtaining and exercising compulsory powers of acquisition, and the ascertainment of compensation on compulsory acquisition. They include the suggestion of imposition of a 'life' on non-conforming buildings; it is suggested that the arbitrator shall assume that buildings which, although not unfit for human habitation, are, by reason of their age, design, construction, arrangement or density, not in accordance with modern standards, will be incapable of use at or before the expiration of ten years. In regard to the central planning authority, the Committee suggests a Minister of National Development, to whom the planning functions of the Minister or Works and Planning should be transferred, who would be responsible for preparing the schemes required to carry out the broad principles of policy determined by a committee of Ministers over which he would preside. He would also be responsible for the control of the developmental rights scheme and the exercise of the powers arising under it, and would be free from departmental responsibilities, but would be assisted by a highly qualified staff. A Commission on the lines of the War Damage Commission, with a full-time chairman and including a member of the economic staff of the Minister, is suggested to secure the proper handling of day-to-day administration and that local authorities, private developers and landowners have ready access to informed advice and authoritative direction.

Such is the bare outline of the scheme and of the argument and principles upon which it is based. The three fundamental principles are unexceptional and are not novel. They have their roots deep in the history of British thought about the land, but for the first time they are here woven into a single pattern for the utilization of the land in the national interest. The lucid analysis with which they are supported should command widespread approval; for there is clear evidence of the forward-looking mind and of the desire to provide for change and the adaptation of system and policy to meet definitely ascertained needs.

There can be no doubt as to the opposition which is likely to be aroused to certain of the proposals: the report points unmistakably to the clash between private and national interests which must be resolved if reconstruction and planning on any adequate national scale are to be possible either now or after the War. That is a task which will require the help of all citizens of goodwill and of vision, if only in the task of education. Moreover, in regard to the central planning authority, the report gives us yet another proposal, although the resemblance to that of the Scott report is more real than might at first sight appear. Less emphatically but no less decisively than the Scott Committee, the Uthwatt Committee distinguishes between planning and development, and although the duties of the Central Planning Commission are less explicitly defined by the Uthwatt Committee, it is clear that a similar type of body is envisaged, although the Uthwatt Committee suggests a body of part-time commissioners, as against a mixed body of full-time and part-time commissioners.

The exact form of the machinery to be established, however, should present no real difficulty now that the problem has been so firmly delineated, the questions to be asked clarified and the principles upon which a solution must be based enunciated with precision and prescience. Already it is clear that the Uthwatt Committee has produced a really outstanding State paper, which will be memorable, both for its intrinsic qualities and for the test it will provide of the capacity of democratic institutions to shape themselves and society to serve the needs of a new age.

A VETERINARY EDUCATIONAL TRUST

IN his speech at the Mansion House recently, at the luncheon held in the course of the congress of the National Veterinary Medical Association of Great Britain and Ireland, Dr. W. R. Wooldridge, the president, announced the formation of a National Veterinary Educational Trust. This development is one that is likely to have a profound influence upon the value of veterinary services in the future and is a result of the increased awareness, within and without the veterinary profession, of the importance of animal health and of the place it must take in the national economy.

This century has seen revolutionary changes in the approach to the maintenance of animal health. At the close of the nineteenth century the development of the Pasteurian concept paved the way for the eradication of certain of the more serious scourges, and for a time achievement in this sphere was mainly concerned with infective processes. The advances made were immense and a new type of veterinarian came into the field, armed with a microscope and trained in the methods of microbial preventive medicine. His achievements were of a high order. Animal diseases that had impeded progress in many countries were brought under control: glanders in Great Britain, rinderpest in South Africa, Texas fever and others are examples of diseases on which successful work was done.

The discovery of vitamins early in this century has led to the realization that these dietary constituents are of great importance to domesticated animals, as they are to man. Later, largely as the result of the start given by South African veterinary workers led by Theiler, certain minerals were found to be indispensable to the life of grazing animals on some types of land. Lack of phosphorus compounds in the pastures had thrown much farm land in South Africa out of production because cattle-farming could not be made profitable, and by the addition of phosphates to the food supply of the cattle the economy of these areas was revolutionized. In addition, calcium, cobalt, copper and other minerals are now known to be essential constituents of the diet of animals and, in many parts of the world, including Great Britain, pastures have been found to lack these elements. The rectification of mineral nutritional deficiency is an important and complex question.

The ravages of parasitic worms infesting livestock have been serious. The life-cycles of many helminths that have been unravelled in recent years are almost unbelievably complex, even to those who know that of the liver fluke; a large number of species of worms is involved, and an extraordinarily wide variety of changes of environment and host is resorted to by different worms in order to ensure a return to a victim of the original species, so that the continuity of the parasite may be maintained. Surely parasitic helminths are the most spendthrift gamblers in existence. Modern intensive grassland husbandry tends to favour the existence of bowel parasites of grazing animals, but fortunately advances in knowledge of the bionomics of parasitic worms, especially during the last two decades, have provided measures that can be used to circumvent the invaders.

To meet the threat of these chemical and biological hazards to the health of our economic animals, extensive knowledge of all the factors involved is required, and the veterinarian is the key link in the chain necessary for the application of the counter-measures.

Chemotherapy for worm infestation and for diseases caused by Protozoa, and, nowadays, even for the control of certain types of bacterial infection, is used on a tremendous scale on animals. Here again the veterinarian is a key man.

The outlook has changed from consideration of the requisite bottle of medicine for treatment of the individual case after illness has become apparent, to the design of measures for application to the animals as a whole, so that disease may be prevented. The name 'veterinary surgeon' almost indicates too accurately the function of the older type of practitioner, compared with that of the modern veterinarian.

Changing agricultural practice has introduced different and new animal disease problems. Foodstuff economies, increased transportation facilities for animal produce and the increased speed of transport between countries have all been contributing factors in these dangers inherent in modern farming. Diseases occur now on farms in Great Britain that were unheard of a generation ago, and not because they were unrecognized previously. Certain metabolic diseases are examples of this trend. The food supply of modern nations demands greater use of high-quality animal products than in the past, and these demands will be intensified in the future. In the absence of adequate supplies of certain of these foodstuffs, human health is menaced, and much active disease in human beings is caused if disease germs are allowed to be present in animal foodstuffs when they reach the consumer. These dangers to human health are, of course, even greater during war-time than in peace. Here again are examples of problems with which the veterinarian must be prepared to deal.

In his presidential address to the National Veterinary Medical Association, Dr. Wooldridge elaborated in some detail his ideas of the manner in which animal disease should be prevented and controlled in the future. He advocated the formation of an Animal Health Corporation, with governors appointed by the State and with powers akin to those of the British Broadcasting Corporation, policy being decided by the Government, but the Corporation having great freedom in the direction of its execution. This Corporation would be responsible for the activities of a complex staff, including specialists in the several branches of the work, practitioners to do the work on the farms, research workers, and a service to ensure that foodstuffs of animal origin are of the necessary quality and free from danger to the human consumer.

Those responsible for policy realize that the future veterinarian must have the best possible mental equipment if he is to play his part. Governments have done much to provide the necessary training, but Great Britain has lagged seriously behind others in this respect, though some improvement has been made during recent years. It is felt that something more is required for higher veterinary education than can be provided from Government sources and, indeed, that public provision additional to Government subsidy is advisable, so that instruction on the widest possible basis free from official control may be available.

The National Veterinary Educational Trust now announced is intended to provide the finances for the extension of the educational organization. An influential board of directors to manage the Trust has been appointed, and it is estimated that a minimum of £1,000,000 will be required. Government departments support the aims of the Trust, and it is anticipated that the necessary funds will be forthcoming.

The Trust would provide scholarships to enable deserving students to become veterinary surgeons, and fellowships and studentships so that those who have graduated may pursue courses of study, or undertake research at home or abroad. Equally, grants would be made to enable graduates aspiring to become veterinary teachers to undertake the necessary post-graduate research, and to assist veterinary surgeons in general practice to take refresher courses. On the other hand, every effort would be made to improve the standard of teaching at veterinary schools and increase liaison with the universities.

The formation of an Animal Health Organization, backed by an active and well-financed Veterinary Educational Trust, such as are envisaged in these proposals, would bring together veterinarians and other workers in many fields bordering on their subject and would give a much-needed stimulus to veterinary studies in Great Britain.

ADMINISTRATIVE EVOLUTION: SERVICE OR TYRANNY?

The Managerial Revolution

Or What is Happening in the World Now. By James Burnham. Pp. iv+271. (London: Putnam and Co., Ltd., 1942.) 7*s*. 6*d*. net.

THE increasing importance of the scientific or technical worker in industry was the theme of one of the most suggestive chapters in Prof. A. M. Carr-Saunders and Mr. P. A. Wilson's study of the professions. Despite, however, all the attention being directed to scientific management, whether through the work of the Institute of Public Administration or the Institute of Industrial Management, the social consequences and implications of the assumption by the technical and scientific staffs of an increasing degree of responsibility for the larger industrial units characteristic of to-day have attracted little attention. Prof. Carr-Saunders and Mr. Wilson's observations, like Mr. S. W. Smith's subsequent paper on the place and function of the administrative and technical worker in the new forms of economic structure, presented at the British Association meeting in 1936, have largely escaped comment. Certainly none of the professional associations of technical or scientific workers appears to have initiated any action to meet the developments and needs thus forecast.

There would be little dissent to-day from the view that organization is a technical problem and that the administration and management of any enterprise must be governed by these few fundamental principles of organization which have been laid bare by the work of Taylor, Fayol, Follett, Dennison, and others in this field. If those are neglected, only inefficiency and confusion can result. A large proportion of our mistakes in the conduct of the War, whether in the field of major policy and strategy or in production, can be traced to disregard of such principles and failure to use the appropriate techniques to serve our ends. The charge has been levelled and established no less against the Civil Service and the Government machine itself than against business and industrial undertakings.

Painful experience clearly enforces the lesson that whether or not administration and management are arts, they cannot be efficient without some use of scientific method and techniques, and the application of established scientific principles. That recognition lies behind all the suggestions advanced from time to time in recent years for a staff college for industry or for the Civil Service, and behind the growing attention which is being given to the training and selection of the men destined to fill the highest positions in industry or the State. Whether or not the administrator of the highest class is born and not made, there is a technique he needs to acquire and an experience which can be thus put at his disposal as an aid, if not a basis, for the skilful selection of the appropriate tool—a scientific technique or some other instrument—which is the essence of an art. The prime qualification for a high administrative position must be administrative capacity, coupling with that the high moral qualities which go to ensure its use with vision, with energy and with courage. Financial, political or social qualifications are secondary or irrelevant factors.

The implications of this change have yet fully to be appreciated. Inevitably as administrative positions come to be filled on grounds of administrative merit, itself dependent to an important extent on professional training and experience, the professional spirit and outlook must influence the policy and conduct of administration whether of industry, of the public utility corporation or of the Government department or local authority. The quality of the administrator and his outlook are far more vital factors in determining the character and efficiency of a public service than its political structure, at least to the extent that without technically competent and upright administrators, no system, from nationalization to the private corporation, will ensure that a really efficient service is rendered. In considering the new forms of organizations to be developed to ensure a right balance between State control and private initiative in reconstruction, we would do well to remember the crucial importance of this factor.

Mr. James Burnham's book gives a new perspective to the problem. He attacks boldly the thesis that socialism is the necessary alternative to capitalism, and while insisting that capitalism is already disappearing, argues that it is being replaced by a new society in which the managerial class has superseded the old capitalist. This process, he argues, is already proceeding. The extension of Government ownership and control means a continuous increase of managerial dominance in the economy as a whole. Every new incursion of Government into the economy means that one more section of the economy is wholly or partly removed from the reign of capitalist economic relations.

Mr. Burnham points out, what so many of the more ardent protagonists of a return to *laisser-faire* and the pre-war chaos in Great Britain fail to perceive, that this process is not being implemented by the Civil Servant type of bureaucrat against whom their propaganda is directed. The new controls are and must be administered by managers of the same type and training as those who are responsible for the management and direction of industry. The position, role and function of the managers depend upon the technical nature of the process of modern production, and the managers of whom he writes tend to think of solving social and political problems as they coordinate and organize the actual process of production. Moreover, arguing that the instruments of production are the seat of social domination and that who controls them, in fact if not in name, controls society, because they are the means whereby society lives, he points out that this social transition leading to the social dominance of the managers may be a corporate dominance, the managers deriving their superior rights and position not as individuals but through their functional status and the actual directing responsibilities which they discharge. Through the possession of privilege, power and command of educational facilities, they will be able to control, within limits, the personnel of the managerial recruits, and the ruling class of managers will thus achieve a certain continuity from generation to generation.

An economic structure based upon State ownership of the major instruments of production provides the framework for the social domination of the managers. It is the only economic structure through which that social domination can be consolidated, and Mr. Burnham does not conceal the fact that such an economy may, though not necessarily, provide the basis for domination and exploitation by a ruling class of an extremity and absoluteness never before known. That warning is reinforced by his exposition of developments in Germany and in the U.S.S.R. as stages in this managerial revolution and his review of the position in the United States, where he insists the New Deal has accelerated the move towards a managerial society.

It is not necessary to accept all Mr. Burnham's interpretation of recent history in Germany and in the U.S.S.R. or even in the United States—and his theory scarcely appears to be entirely viable in the former two—to realize that the considerations advanced must be seriously regarded in determining the institutions to be established to serve post-war needs in Great Britain. Conclusions which are not altogether convincing should not lead us to ignore or discount the shrewd observations on which the argument is based—for example, the comparative absence of managers from the forced or voluntary refugees from Nazi Germany.

This outstanding essay on the changing shape of society raises two issues of the utmost fundamental importance. In the first place, the chapter on the economy of managerial society is clearly describing an aspect of planning on which Walter Lippmann launched a brilliant attack in "The Good Society". Under a managerial economy, as described by Mr. Burnham, planning becomes a matter of course, and while such an economy is better placed than capitalist economy to make use of new inventions and technological devices, certain limitations in individual freedom of labour and bargaining, at the least, must be accepted. These are the price to be paid for the stimulus to production and to the more effective planning of the economy as a whole, with all the advantages in a higher material standard of living which are inherent in a managerial economy.

Whether this is too high a price to pay for that greater ability to plan and easier realization of the aims of planning, depends largely on what those aims may be, and Mr. Burnham's assertions as to those aims must be firmly challenged. Here as elsewhere he is far too pessimistic. Scientific humanism may well be far more capable than he admits in giving sound values to a social structure which would otherwise be intolerable. In recognizing the professional solidarity of the managerial class, he discounts too much the influence of the professional ideal and outlook stressed by Prof. Carr-Saunders and Mr. Wilson. Neglect in the past by professional associations of their responsibilities towards society does not warrant the belief that the professional spirit will be displaced so absolutely by self-interest as Mr. Burnham suggests. The evidence is rather the other way; and the conclusion is that we should see that the new privileged class of managers is imbued with the same standards of integrity and loyalty as the Civil Service and with those standards of public duty which have characterized our aristocracy at its best in the past.

This somewhat superficial analysis naturally strengthens the argument of those who, with Walter Lippmann, contend that society should be unplanned because it is difficult to set limits on planning which preserve the essential human liberties. The merit of Mr. Burnham's book, however, lies rather in directing attention to a social phenomenon requiring close examination than in the acuteness of its analysis. This is again apparent in the chapters on the shifting centre of sovereignty and on totalitarianism and managerial society, where a second fundamental issue is raised. To compare these chapters with corresponding passages in Prof. Barker's "Reflections on Government" might be unfair, but demonstrates the shallowness of Mr. Burnham's understanding of the nature and working of democratic institutions. That is the fatal weakness which handicaps his delineation of a solution of the problems which he outlines so suggestively.

Though the U.S.S.R., Germany and Italy, the nations which have advanced furthest towards the managerial social structure, are all at present totalitarian dictatorships, Mr. Burnham holds that with the consolidation of the structure of managerial society, its dictatorial phase will change into a democratic society. He considers that certain aspects of a democratic society favour the more efficient functioning of managerial society; on this point Mr. R. B. McCallum's valuable article on the "Future of Information Services" in a recent issue of *Agenda* is highly pertinent. But Mr. Burnham fails to see how democratic institutions can be used to define the objectives of planning policy, for example, and to exercise that control over the managers which will ensure that they serve the ends of society and not society those of the managers. Under a managerial society all major parts of the economy will be planned and controlled by a single integrated set of institutions, but while he sees clearly that a one-party State is incompatible with democracy, he misses the whole idea of the evolution of new social controls on which Mannheim lays such stress in the planning for freedom.

Mr. Burnham has written a provocative book over which scientific workers may well ponder, though undismayed by its pessimism and the rather gloomy tones of the picture it portrays. The problem is set forth fairly enough: Who shall control the planners and how? The necessity for a wider planning of the major aspects of social and economic activity in the broadest sense is inescapable. The problems we have to face are those of defining the objectives and elaborating the social controls required to reconcile planning with the retention of those essential human liberties without which the human spirit droops to slavery. It is unthinkable, however, that professional men, and above all men of science who have so large a part to play in that planning, will not bring to their task a spirit no less generous and disinterested than they have brought to the quest for truth, or that their professional solidarity, whatever may have been its temporary shortcomings or aberrations, will not remain unshakably loyal to that tradition of service and integrity to which the professions owe alike their essential inspiration and vitality.

R. BRIGHTMAN.

SCIENCE AND CURRICULUM REFORM

Science and Education

By S. R. Humby and Dr. E. J. F. James. (Current Problems, No. 15.) Pp. ix+146. (Cambridge: At the University Press, 1942.) 3*s*. 6*d*. net.

OUR educational system no longer serves adequately our needs or aspirations and, under the stress of events which help to reveal its shortcomings, the outlines of a new policy are being hammered out. In the discussions that are taking place, the field of curriculum reform has been somewhat neglected. Yet here, too, changes are very obviously necessary: the anachronistic curriculum of our secondary schools, for example, not only lacks coherence and unity but also is largely irrelevant to the needs of the future citizens of an industrial democracy. A course of study suited to such a society would be centred on the social and natural sciences. Traditionally, however, the aim of the secondary school is the somewhat vague one of developing in its pupils an appreciation of literary culture. Consequently, linguistic studies secure the lion's share of the time available. The result is not only a loss of industrial efficiency but also a lack of grip on the part of administrators trained to think in categories irrelevant to many of the situations they meet, and called upon to deal with forces they can neither understand nor control.

These are some of the problems discussed in a short but important book by two science masters at Winchester. Their first chapter, on "Science and Society", is devoted to an exposition of views not unlike those propounded by Prof. Bernal, Dr. Lovell and others. The authors conclude that much more could be done to make available to all the fruits of science if one could bring about a new outlook through an improved education. "Civilisation is unaware both of the extent to which it has been modified by scientific discovery in the past and of the potentialities that extended and co-ordinated research open for the future . . . this lack of awareness has its origins in our educational system . . . [Many] educated men and women remain resolutely unaware of the way in which [scientific] discovery . . . might revolutionise society in the future". One wonders whether, in fact, the problems can be solved merely by teaching people the right things. Such optimistic views were common in the eighteenth century, but are they correct ? The use of the word "resolutely" in the passage quoted is significant.

In their second chapter, the authors describe in a brief but highly interesting way the history of science teaching. They remind us of the struggles made, all through the nineteenth century, by enlightened individuals and by Government commissions, to introduce scientific education into schools. The compromise achieved as a result of all these efforts is, of course, familiar. So far as possible, the old framework was preserved, but a minor place was made for science, which was given a time-allowance too small for average pupils but just sufficient to awaken the interest of a few brilliant and specially gifted boys. At the same time, technical education was provided—that is, a system was specially devised to serve the bare needs of industry. Thus, technicians and men of science were provided in fair number, but the rich cultural possibilities of a full scientific education were left largely unexplored. Incidentally, the still-born Spens Report favoured the extension of this unsatisfactory solution.

From the whole of this disturbing story, the authors conclude that, "the present faulty relationship between science and social needs is primarily an educational problem, and the first steps to its solution must be taken in the schools and universities". This may well be so, and it is certain that social and educational problems are interrelated. At the same time, one wonders uncomfortably whether, in this proposition, the cart has been put before the horse. Can changes in education precede and initiate social changes ? Can there be an educational system which accepts and pursues values different from or opposed to those accepted by the community it serves ? Are not the most powerful and influential groups in society averse to change ? Is it just accidental—merely the result of ignorance—that the literary and not the scientific studies play the paramount part in education ? On all such points sociologists have interesting things to say.

The remaining three chapters of Mr. Humby and Dr. James's book are devoted to matters of smaller but more immediate importance—to "The Content of Science Courses", to "Problems of Presentation" and to "The Teaching of Scientific Method". The authors are distinguished teachers of considerable experience and they have many wise and cogent things to say—on general science, on practical work, on quantitative experiments, on the uses of the history of science and so on.

Their book is short and the task of selecting topics for discussion must have been a very difficult one. Yet a few omissions should be noted, since one has the feeling that consideration of them might have served to modify, in detail though probably not in principle, some of the conclusions reached. Thus, one wishes they had discussed the place of biology, a subject particularly suited to schools. Again, it might have been profitable to take into account the possible uses of radio and cinema: these new media are likely in time to have a tremendous effect both on the content of science courses and on the methods of teaching it. Perhaps, too, the authors might have taken note of the highly important work on the technique of examinations done in Chicago by Prof. Tyler and his school. These workers have devised ingenious methods of evaluating the progress made by learners in developing scientific attitudes and in mastering the scientific method. Lastly, it would have been interesting and useful to read a critique of the proposals made by the Progressive Education Association. The course of science education proposed by the Curriculum Commission of that Association is based on a large-scale research by sociologists, psychologists and educators, it has been well tried in practice, and it represents the most scientific attempt at curriculum reform so far made.

To complain about such omissions in a book which one has greatly enjoyed reading and from which one has learned much may seem ungracious; it will, I hope, be taken chiefly as a request for more. The book as it stands, though short and condensed, is a real and valuable contribution to the solution of urgent educational problems. One hopes it will be widely read and studied. Teachers in universities and colleges will find here in outline a description of what the best teachers in secondary schools are trying to achieve; and teachers in secondary schools would undoubtedly gain much from the helpful and stimulating discussion of problems they constantly encounter.

J. A. LAUWERYS.

TITRATION EXPLAINED

Volumetric Analysis

By Prof. I. M. Kolthoff and V. A. Stenger. Second revised edition. Vol. 1: Theoretical Fundamentals. Pp. xv+309. (New York: Interscience Publishers, Inc.; London: Imperia Book Co., Ltd., 1942.) 4.50 dollars.

THIS is an instance of a magic carpet, though we suspect it was really a steamer, which has transplanted a professor and his book from Europe to the Americas, the language changing during the process from German to Anglo-Saxon. The original German work was published in 1927 and translated for publication in New York by Prof. Furman. Prof. Kolthoff now has the collaboration of Dr. Stenger, a chemist employed in industry. This is a significant indication of the alliance between theory and practice which is so marked a feature of American science.

No book has had more influence in developing the understanding of chemical reactions than Wilhelm Ostwald's "Theoretical Foundation of Analytical Chemistry", published in 1894. Until then analytical chemistry and its development was mainly empirical, and though this must still be partially necessary in a subject which has a practical goal, it is to-day accepted that with the aid of theoretical information it is possible both to improve existing methods and to devise new ones.

This statement is particularly true of volumetric analysis, a branch which has become of increasing importance. The progress of an experimental investigation often depends on the ability to make measurements in large numbers which in turn means, quickly. Weighing is too slow, whereas titration can be quick. Hence the urge to develop it, especially by biochemical investigators; at first speed is more essential than great accuracy, but eventually greater exactitude is required. A distinction can be drawn between the methodic or technical errors and the intrinsic errors based on the chemical reaction in volumetric analysis. The methodic errors are due to imperfections in measuring apparatus and technique and in the human factors; such errors affect the reproducibility of a titration and can be treated statistically if enough determinations are made.

This is Volume 1 of the work and treats the theory of volumetric analysis apart from the practice; there is division into ten chapters. One of the most valuable of these relates to indicators of which to-day there are a goodly number, which are grouped under three headings: (1) for acid-base reactions; (2) for precipitation reactions; (3) for oxidation-reduction reactions. The last group is of considerable interest to-day and is considered at some length in the book.

The book is clearly written having regard to the complexity of the subject; and now that we all have a considerable knowledge of physical chemistry should assist those, particularly biochemists, who seek to use volumetric methods. It contains some useful data in an appendix.

E. F. A.

MARRIAGE CUSTOMS IN THE MAKING

Marriage and Family in Mysore

By M. N. Srinivas. Pp. iv+218. (Bombay: New Book Co., 1942.) 7.8 rupees.

MR. SRINIVAS, writing with the valuable equipment of a sympathetic understanding of Hinduism and of the traditional values expressed in the customs of Mysore related to the family, and appreciating, with the objective view of the anthropologist, its social structure, has presented readers with a valuable study. The picture of the attitude to marriage current in a Hindu community to-day shows the trend of changing customs. One would welcome similar studies of different communities made by those belonging to the tradition of the communities studied, equipped with a scientifically trained mind and a wide knowledge of functional anthropology and social psychology. A group of such studies would throw much-needed light on the evolution of the family, and might well disclose a recognizable pattern of development, thereby proving a valuable guide to the social biologist.

While acknowledging his indebtedness to Westermarck, and his appreciation of the work in Mysore of Ananthakrishna Iyer, Mr. Srinivas does not hesitate to challenge both in their interpretation of certain Kannaka customs, particularly 'bride-price', 'marriage by capture' and an assumed earlier matrilineal social structure, I think, with some justification.

The author's first-hand knowledge of local practice in many instances clarifies the position. Take, for example, the complicated customs grouped under the term 'bride-price'. The two conflicting ideas—each forming part of the protracted marriage ceremony—of payment for the bride (twice as much for a virgin as for a widow) and of the free gift of the daughter by the father are expressed in the marriage rites. 'Evidence is available to prove that 'bride-price' once prevailed in every caste and region of Dravidian India" (p. 20). Brahmans as well as non-Brahmans practised it, and up to fifty years ago girls were frequently sold among the Brahmans for sums ranging from R. 300 upwards. On the other hand, the representatives of a group of Brahmans signed an agreement in the Saka year 1347 "to the effect that henceforth the father had to give his daughter to the bridegroom gratuitously. Both the father who accepted money and the bridegroom who paid money for the bride should be subject to punishment by the king and excommunication from their caste." The lower castes tend to copy the customs and ceremonies of the Brahmans; new customs, often conflicting with those that were indigenous, were adopted from invading peoples. This is seen in the wide variation in marriage restrictions, exogamy of various kinds and degrees. One of these restrictions—'gotra exogamy'—is rigidly observed by Brahmans even to-day. "In the desire to elevate their social status many non-Brahman castes have recently acquired 'gotra' (ancestor groups). This shows that a decadent institution may acquire a new prestige through it being made the symbol of a new superiority. This tendency, unfortunately, appears to apply to the re-marriage of widows. While the educated Brahmans are beginning to relax the restrictions on re-marriage, sub-castes that previously permitted the marriage of widows are now prohibiting them in emulation of the customs of the higher social groups" (p. 126).

Both Brahmans and non-Brahmans agree in prohibiting the marriage of cousins, but among the educated to-day the restrictions are applying less and less to 'cross-cousins'.

One would like to know more of the trends and influences being derived from the impact of Western thought. In Mysore, among the indigenous groups the author notes a new one "called the 'London Party' formed from descendants of those who dared to cross the sea". They were boycotted at first, but being rich and influential this fashion passed; now "in all the sub-castes an England-returned bridegroom is sought after, highly bid for, and the girl who buys him is considered lucky".

In some of the customs quoted, there is opportunity for comparative study which should prove fruitful. For example, in one tribe that migrated to Mysore from Northern India, as part of the marriage ceremonies the girl has to weep and show resistance. Rejecting the 'marriage by capture' origin of the custom, the author postulates three possible explanations: the bride's reluctance to leave her parents, or that weeping at the wedding prevents misery later, or the resistance symbolizes the sexual frigidity of the woman. It is interesting that in Albania some thirty years ago, it was the custom of the Moslem bride, dressed in her wedding finery (and the practice was copied by the local Christians), to weep for two days before the wedding.

The book is commended to those concerned with the place of marriage and the family in the community as a thought-provoking study. The influence of any social ambitions and current values in the emphasis given to religious sanctions indicates the way in which changes in interpretation and practice may come about. For an adequate understanding of the problems involved the help of the psychologist as well as the anthropologist is essential.

S. Neville-Rolfe.

ENTOMOLOGY CONDENSED

Outlines of Entomology

By Dr. A. D. Imms. Pp. vii+184. (London: Methuen and Co., Ltd., 1942.) 12*s*. 6*d*. net.

THERE was a time, perhaps it is not entirely past, when entomology was among the least of the biological sciences; when the cockroach was held to epitomize the class; and when a specialist on the

Ctenophora might be credited with a knowledge of zoology, but scarcely a specialist on the Insecta. Yet insects have provided the material for most of the biological theory of the past fifty years: sex determination, biological races and species formation, mutation and heredity, bioluminescence, mechanisms of behaviour, biological oxidations, the inheritance of acquired characters, adaptive coloration, theories of population, the physiological action of genes—these are a few of the subjects which owe much to the diversity of insects and the unrivalled opportunities they offer for studying the workings of the living organism. The utilization of this material in many fields of physiology and biochemistry has scarcely begun. Much of insect physiology still consists in confirming upon insects what is already known from studies of higher animals. But the tissues of insects are so accessible, and experiments can be made upon them with such facility, as to encourage the hope that there are many more fundamental problems in biology the analysis of which may be pressed further and with greater ease upon insects than upon other forms.

At the same time insect pests constitute an ever-present threat to the health of man and animals and to our supplies of food and raw materials; a threat which is not diminished in time of war. The work of those who combat harmful insects rests upon an elaborate foundation of insect systematics, ecology and physiology. The applied entomologist to-day demands ever-greater refinements in taxonomy. Taxonomy pressed to the limit is apt to transcend the powers of the museum worker and become a matter of biological races whose distinguishing characters can be recognized only in the field by studies in ecology. At every turn the ecologist and the applied entomologist are confronted with problems in physiology.

To unify this subject and to present it as a whole with proper emphasis on all its several parts is a task that demands experience and judgment. Dr. Imms placed entomologists the world over in his debt by the production nearly twenty years ago of his "General Textbook of Entomology". He has now attempted the formidable task of condensing the essence of his subject into a book of 184 pages. It may be said at once that he has succeeded to a remarkable degree. The book falls into two equal parts: anatomy, physiology and development; and nomenclature, classification and affinities. In both parts the allocation of space and the quantity of detail given have been decided with very sound judgment. It is an austere book "intended for anyone who is willing to take sufficient pains to acquire an elementary knowledge of entomology as a branch of general zoology", and it makes no concessions to those who like to escape technical terms. The whole of terminology is here, sometimes in such concentrated form that concentration will be needed also by the student. But the presentation is uniformly excellent.

On the physiological side (the descriptions of function fit in naturally with those of structure) the point of view of recent surveys is adopted. This marks a distinct change from the "General Textbook" in which the presentation, apart from the inclusion of some recent work, has remained substantially that adopted by Packard. In a book so concise as this, there are, of course, physiological allusions which the first-year student for whom the book is intended would probably not understand. But if he is driven to seek information elsewhere they will have served a useful purpose.

In a book so well planned and indexed and so free from errors of typography and fact it is difficult to make constructive criticisms. But since controversy is the stuff of science, one might challenge the justification for the term 'prepupa' (p. 92). Moulting in any insect at any stage is necessarily preceded by some degree of quiescence and by some change in outward form determined by the changes in the new instar. When the new instar is markedly different the period of quiescence and the outward changes are more in evidence. It is difficult to see the value of calling this period a prepupal instar.

The second half of the book in which the characters and mode of life of all the orders of insects are summarized is remarkably well done, though the descriptions are necessarily very brief. This part is lightened by a series of 'appendixes' on more general questions: an account of the phase theory follows the section on Orthoptera; a review of 'fecundity and biological equilibrium' follows the Homoptera. Other examples are 'insect colours' after Lepidoptera; 'aquatic insects' after Coleoptera; 'social insects' after Hymenoptera; 'parasitism' after Diptera. All these are good.

The book as a whole challenges comparison with Weber's "Grundriss der Insektenkunde", likewise written as a student's introduction to a larger work. The excellent illustrations of Dr. Imms's book have not the dramatic quality of Weber's. But as befits an English book the essence of the subject has been distilled into a much smaller compass, and the student who takes Dr. Imms's "Outlines" as his first guide to serious entomology will have started well.

V. B. WIGGLESWORTH.

A NATURE DIARY

Wild Life through the Year

By Richard Morse. (Black's Nature Pocket Books.) Pp. 158 (58 plates). (London: Adam and Charles Black, Ltd., 1942.) 7*s*. 6*d*. net.

RICHARD MORSE in this attractive book takes us with him through each month of the year. The author in his preface hopes that readers of this book may be induced to keep Nature diaries of their own—an admirable suggestion and one which gains rather than loses its force in these grim days. Mr. Morse tells us when to watch for the spring bird migrants and when to be on the look-out for the early flowers and butterflies. The book will be a help to many who love Nature but are in need of a clear and simple guide.

I should say that April rather than March is the puffins' month (p. 28) for arrival at their nesting stations; the puffin is at least a month later than either the razorbill or the guillemot. When Mr Morse gives March as the month in which the red deer casts his antlers he is perhaps referring to the park stags of England; the Highland stag rarely casts his horns until April, and sometimes not until May. In his account of the autumn breeding of mammals, the author might perhaps have mentioned the Atlantic seal, which has its baby in September October, or even November.

The book is illustrated by a number of good photographs, and there is an interesting series of twelve whole-page line drawings, the art of Miss Doris Meyer. It makes a good Christmas gift and deserves a wide circulation.

SETON GORDON.

Elementary Mathematics

By Prof. Hyman Levy. (Nelson's Aeroscience Manuals.) Pp. 216.

Modern Trigonometry

By M. J. G. Hearley. (Nelson's Aeroscience Manuals.) Pp. 168.

(London and Edinburgh: Thomas Nelson and Sons, Ltd., 1942.) 5*s*. net each.

THE utilitarian aspect of mathematics has been well emphasized in the declaration that "Mathematics is ever ready to serve, and it rules because it serves". The present conflict has undoubtedly called forth no inconsiderable development of the practical nature of the subject. As a consequence, quite a number of books have been issued, mainly for use in Service training.

There is no short cut to the realm of mathematical knowledge and skill, but the long road may be traversed more quickly and easily if the traveller's interest is vitally stimulated. In the two books under notice, this aim has been commendably attained. The volumes belong to a series designed to cover the field of science underlying the principles of aeronautics.

As would be expected, Prof. Levy's "Elementary Mathematics" is an inspiring tonic. In its seventeen chapters, the reader is led from first principles right into the heart of the subject by simple logical steps which are so attractively presented that the student is not only making useful progress, but also is amazed to find eventually what a practically interesting subject this alleged abstruse and meaningless mathematics really is! He becomes familiar with the varieties of number, including vectors; with the fundamental facts of geometry and algebra; with the conception of a function and the basic ideas underlying the calculus. He is also taught to 'calculate' properly, with or without logarithms, tables of which are provided. It is indeed quite probable that the sincere reader will, like the famous character of Dickens, ask for more!

Mr. Hearley's "Modern Trigonometry" is designed to provide a fresh and interesting introduction to the subject. The practical nature of trigonometry is well developed by the inclusion of so many applications, and not only these, but also the attractive presentation of the text, reveal how well the aim has been carried out. The student will appreciate here the fundamental part of trigonometry in navigation and modern engineering. Besides answers to the exercises, the necessary tables are provided.

F. G. W. BROWN.

Chemical Industries

Chemical and Physical Data, Chemical Engineering, Glossaries of Industrial Chemicals, Pharmaceuticals, Constructional Materials, Perfumery Raw Materials, Directory of Plants and Materials. Edited by L. Ivanovszky. Sixteenth edition, largely rewritten and revised. Pp. 338. (London: Leonard Hill, Ltd., 1942.) 15*s*.

THIS is one of those books that everyone dealing with chemicals likes to have on his desk. It begins properly with the index so that we can find the information required, and is divided into sections dealing with constructional materials, power plant and water treatment, chemical plant, handling, conveying and transport, instruments and apparatus. Finally, there is much information about industrial and fine chemicals, including a glossary of trade-names.

The advertisements of the firms prepared to supply all our requirements come boldly after each section, as they do on the front pages of the daily papers, instead of being hidden away at the back.

It is one of those books which, when we have become used to it, makes us wonder how we have done without it previously: it is hoped to make it an annual publication.

It is noted in the preface that Prof. D. M. Newitt, who has been associated with the preparation of the volume since the first edition, has now ceased to take any active part.

Science Looks Ahead

By Prof. A. M. Low; with Contributions by Dr. Julian Huxley, C. G. Grey, G. E. T. Eyston, F. Kingdon Ward, Dr. H. Spencer Jones, Sir Alliott Verdon-Roe. Pp. 640+47 plates. (London, New York and Toronto: Oxford University Press, 1942.) 12*s*. 6*d*. net.

PROF. A. M. Low is well known for his presentation of scientific and technical advances in popular terms. In the present volume, he has attempted a survey in descriptive terms of recent developments in many fields. In successive chapters he discusses sources of power, rays, science and war, materials of industry, transport, measurement, medicine, the sea, exploration of the universe, weather, communications, exploration, the cinema, and science and the criminal. Dr. Julian Huxley provides a chapter on evolution, Dr. H. Spencer Jones one on the planets, and Capt. F. Kingdon Ward two on food plants and 'living' fossils respectively; while C. G. Grey deals with aeroplanes in war, Capt. G. E. T. Eyston with speed records and Sir Alliott Verdon-Roe with flying. The forty-seven plates illustrate outstanding features of the articles they accompany, and there is a useful index.

A History of Tropical Medicine

Based on the Fitzpatrick Lectures delivered before the Royal College of Physicians of London, 1937–38. By Sir H. Harold Scott. Second impression. Vol. 1. Pp. xix+648+3 plates. Vol. 2. Pp. iv+649–1219+ plates 4–13. (London: Edward Arnold and Co., Ltd., 1942.) 63*s*. net.

THIS is the second edition of a book which was first published so recently as 1939 and reviewed in NATURE of November 11, 1939, p. 801. Volume 1 deals first of all with the history of tropical medicine in the navy and mercantile marine, the army, the Colonies, Protectorates and Dominions, India and Australia. It then proceeds to a consideration of the history of malaria, blackwater fever, yellow fever, trypanosomiasis, leishmaniasis and leprosy. Volume 2 continues with diseases, namely, cholera, plague, undulant fever, relapsing fever, meloidosis, dengue, amœbic dysentery, hepatitis, ankylostomiasis and tropical diseases connected with food. Some special areas, namely, the Suez and Panama Canals, are then reviewed, and the diseases connected with the slave trade are considered. Fifteen biographies are appended, and the book ends with a bibliography, appendix and author and subject indexes.

BLAISE PASCAL (1623-1662)

TERCENTENARY OF THE CALCULATING MACHINE*

By Prof. S. CHAPMAN, F.R.S.

THE production of the first calculating machine was important in itself, and still more because it started the progress towards the many intricate and powerful computing machines now available. But the inventor was far greater than this invention.

Pascal's life was short, and clouded by much illness; he died at the age of thirty-nine. But his achievements were so varied and remarkable that he has become the subject of an extensive literature, ever growing as each age interprets him anew. In the words of T. S. Eliot, the history of men's opinions of Pascal, and of other men of his stature, is a part of the history of humanity.

What were Pascal's achievements, and what manner of man was he? He was a mathematician and geometer, who at the age of sixteen made the first great advance in synthetic geometry since remote antiquity; by his famous theorem on a hexagon inscribed in a conic section he won the recognition of the most learned men of his time. But he was not simply a man of books, pen and paper; he was eminent as an experimental physicist, for his studies on the equilibrium of fluids, on the pressure of the air, and on the creation of a partial vacuum; he also designed the hydraulic press, constructed long afterwards by Bramah. Further, he was a practical inventor, as we specially remember here. He it was who invented the wheelbarrow in its present form; previously there had been hand-carts, like the coster's barrow, but Pascal designed the one-wheeled barrow, and applied the same idea to the sedan chair.

This mathematician, physicist and inventor was well taught by his father in languages and philosophy. Of good family, their home life was one of culture and fine manners, and they were accustomed to the society of the noble and eminent; father and son had much in common.

The father died when Pascal was twenty-eight, and for two years he lived in style, mingling with the men of wealth and position around the court of the Grand Monarch, and sharing many of their pleasures —music, the ballet, the chase, the gaming table, the conversation of women, the fascinating affairs of war and the State. Besides being a good spender of money, Pascal knew how to add to his wealth by business enterprise.

But at thirty he turned from these activities and distractions. Hitherto a faithful Catholic living in the world, he now became deeply concerned with religion, partly through the influence of his younger sister. She, a young woman of great strength and beauty of character, had already entered the religious community of Port-Royal, the centre of a puritan reform movement within the Roman Church, inspired by Jansen, the Bishop of Ypres. A year after these stirrings of deeper feeling, Pascal had an ecstatic religious experience, and for the remaining eight years of his life he was closely linked with the abbey and schools of Port-Royal.

He still lived in his own house, and retained much of his wealth. But he mortified his flesh by an ascetic rigour even beyond that which his physicians imposed to relieve his increasing ill-health. His asceticism, however, like that of St. Francis of Assisi, was accompanied by lovingkindness to others.

Among the vanities of the world which Pascal now renounced were his mathematics and his science. But he did not wholly abandon them. From time to time, through intercourse with such friends as Fermat and Mersenne, and sometimes simply as a distraction from pain, his thoughts returned to these pursuits, in which his mind moved with perfect ease and grace. Almost without effort he made new discoveries in the geometry of the cycloid and in the theory of probability; he even engaged in scientific controversy on questions of priority.

In these last eight years, however, he won new fame as a writer on religion. Strife arose between the Jesuits and the Jansenists. The Jesuits charged the community of Port-Royal with heresy, and the austere Jansenists attacked a Spanish group of Jesuits whose casuistry they regarded as dangerous to morality. Pascal engaged in the controversy, and wrote eighteen letters called the Provincial Letters. French literary critics acclaim these prose writings as of capital importance in the foundation of French classical style. As polemic, says T. S. Eliot, they are unsurpassed, not by Demosthenes, or Cicero, or Swift.

In his last two years, Pascal meditated writing an intellectual defence of Christianity, and made copious notes for it. He died before beginning the actual writing, but these notes were published, after his death, as the famous "Pensées" of Pascal. Even these fragments reveal him as a great literary artist, whose intellectual passion for truth made him utterly dissatisfied without a spiritual explanation of human life. He brought to this work his great powers as a man of science, though he did not, like some scientists, suggest that his own faith was sufficient warrant in itself for Christian belief by the common man. Voltaire and Condorcet might regard Pascal's religious writings as the product of a mind disordered by ill-health, but in these poignant days, so tragic especially for our sister-nation, to which these three great men belonged, Pascal's "Pensées" have a renewed interest, though some of his presuppositions are now shared by few educated men.

Pascal was proudly conscious of his intellectual powers, but he became also profoundly humble as a sinful man before God, and in his last years he was filled with loving concern for the poor. His wish to supply their material needs spurred his practical genius to start a company for putting public vehicles, omnibuses, on the streets of Paris, for the convenience of the people, and to gain profits, no longer for himself, as in his earlier years, but for almshouses and hospitals. These buses were started during the last months of his life, and deeply engaged his attention; they seem to have achieved instant social and commercial success.

Newton, whose birth we celebrate in this tercentenary year, was a greater man of science than Pascal, but I judge Pascal to be the greater man. Newton's thoughts, like Pascal's, turned much to religion in his later years; but he followed dark paths, pondering over the prophetic Scriptures; none but the curious antiquary would to-day read his religious writings. Pascal's, on the other hand, have an abiding attraction both in their substance and their literary form. Newton was a man of virtue and plain living; but Pascal in his later years was a saint. Newton's scientific work, though great in substance, was written in poor Latin. Pascal used his native language in writing both on science and religion, and his works belong to the great treasury of French literature.

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* Address delivered at a memorial luncheon held in London on October 19.

Pascal's invention of the calculating machine, just three hundred years ago, was made while he was a youth of nineteen. He was spurred to it by seeing the burden of arithmetical labour involved in his father's official work as supervisor of taxes at Rouen. He conceived the idea of doing this work mechanically, and developed a design appropriate for this purpose; showing herein the same combination of pure science and mechanical genius that characterized his whole life. But it was one thing to conceive and design the machine, and another to get it made and put into use. Here were needed those practical gifts that he displayed later in his inventions of the wheelbarrow and the omnibus. He must find and test suitable materials for his machine—iron, copper, ivory, ebony, wood. He must find and indeed train suitable workmen, and settle many points by actual trial. His first model was followed by others, and gradual improvements occupied much of his time for the next ten years, in which he strove indefatigably after perfection. He wished also to obtain due reputation and reward from his invention. He obtained royal protection for it, and gained the patronage of many distinguished men. In 1652 he presented one of the last of his fifty models, with a famous letter, to Queen Christina of Sweden. He also wrote a prospectus of his invention that would do credit to a modern school of salesmanship. But other men, despite the royal patent, pirated his invention; and the sight of one of these copies, "a monster", he said, fair on the outside but valueless in use, so disgusted him that he abandoned further interest in his machine.

In a sense, Pascal's invention was premature, in that the mechanical arts in his time were not sufficiently advanced to enable his machine to be made at an economic price, with the accuracy and strength needed for reasonably long use. This difficulty was not overcome until well on into the nineteenth century, by which time also a renewed stimulus to invention was given by the need for many kinds of calculation more intricate than those considered by Pascal.

Consequently until the present century the principal aid to calculation was the table of logarithms published by their Scottish inventor, Napier, in 1614, put into more practical form by Briggs at about the time of Pascal's birth, and afterwards used also in the slide-rule.

These inventions will always retain great practical value, but where extensive and elaborate calculations are necessary the economic method is to use a suitable computing machine. To-day we recall Pascal as the first originator of such machines.

ECONOMY IN THE USE OF FERRO-ALLOYS*

By DR. W. H. HATFIELD, F.R.S.

IN times of peace, particularly if they are of long duration, the qualities and characteristics of that which is produced are the result of tradition and usage, salesmanship, and the developments due to technical progress based on the application of old or new knowledge. Tradition, usage, and salesmanship slow up in measure with the inevitable progress towards the realistic efficiency possible through knowledge and the consolidation of technical progress. War and preparation for war insist upon stark efficient realism, and those who prepare for war are given more time to attain to it than those who are unexpectedly called upon to face such conditions. Also, in times of peace, international trade throws open to all countries the world's resources in raw materials and facilities on an economic basis; war rudely disturbs this state of things, and realism in production must then deal with a limited or changed availability of that upon which production can continue.

These conditions apply at the moment to the production of steel, and particularly to special and alloy steels. Concerted efforts are being made within the industry to attain maximum efficiency based on the availability and changing availability of raw materials and facilities. It will be obvious that technology and technique so developed can be, and will be, projected with advantage into post-war times.

ELEMENTS OF INTEREST IN STEEL METALLURGY.

Element	Group	Date isolated	Metal isolated by	Nationality
Hydrogen	I	1766	Cavendish	British
Copper	I	Prehistoric		
Zinc	II	Prehistoric		
Aluminium	III	1854	H. St. C. Deville	French
Carbon	IV	Prehistoric		
Silicon	IV	1854	H. St. C. Deville	French
Titanium	IV	1825	Berzelius	Swedish
Zirconium	IV	1824	Berzelius	Swedish
Tin	IV	Prehistoric		
Lead	IV	Prehistoric		
Nitrogen	V	1772	D. Rutherford	British
Phosphorus	V	1669	H. Brand	German
Vanadium	V	1830	Sefstrom	Swedish
Arsenic	V	1240	Albertus Magnus, Bishop of Regensburg	German
Niobium	V	1801	Hatchett	British
Oxygen	VI	1774	Priestley	British
Sulphur	VI	Prehistoric		
Chromium	VI	1798	Vauquelin	French
Selenium	VI	1818	Berzelius	Swedish
Molybdenum	VI	1782	P. J. Hjelm	Swedish
Tungsten	VI	1783	F. D. and H. J. D'Elhuyar	Spanish
Manganese	VII	1774	J. G. Gahn	German
Iron	VIII	Prehistoric		
Cobalt	VIII	1742	Georg Brandt	Swedish
Nickel	VIII	1751	Cronstedt	Swedish

It is perhaps of value to consider the twenty-five elements which are of direct interest in the production of steel. In the accompanying table those elements will be found scheduled. They can be divided substantially into four groups, namely, (i) the dominant alloying elements, (ii) the secondary alloying elements, (iii) appertaining and arising essentially as regards process, (iv) for protective coating.

Of these twenty-five elements, knowledge of seven—copper, zinc, carbon, tin, lead, sulphur, and last but most important of all, iron—was bequeathed to us by early civilizations, and a period of some two thousand years passed before we seriously began isolating those which are now so useful. Of the dominant alloying elements, namely, manganese, chromium, nickel, molybdenum, tungsten, cobalt and vanadium, it is of great interest to note that four of these elements were originally isolated in Scandinavia, one in France, one in Germany and one in Spain, while of the secondary alloying elements, aluminium, titanium, zirconium, niobium, selenium and copper, three were isolated in Scandinavia, one in France, and one in Britain; the last-mentioned, copper, was employed in prehistoric times.

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As regards the elements iron, carbon, and silicon, these are so fundamental as almost to escape notice, but while iron and carbon date from prehistoric times, silicon was only isolated in 1854 in France. Hydrogen, nitrogen, phosphorus, arsenic, oxygen, sulphur are to be looked upon as essentially impurities arising from process, while zinc and tin are used for coating steel in protection against rust (as of course in smaller degree are cadmium and nickel).

In an effort to be able to present a complete picture, I have sought to: (*a*) schedule the production of the relevant raw materials as regards country of origin; (*b*) schedule the countries where the raw materials were smelted or reduced to a usable form; (*c*) schedule the origin of the relevant raw materials used by the different steel-making countries. Such statistical evidence merits careful study, and although not sufficiently available for a complete statement, does point to facts of great interest.

The volume of production of an ore in a country is indicative of the achievement of economical winning but not necessarily of the resources prevailing. There may be great quantities of low-grade ore, railways may not be available and population of a suitable character may not be there. Distance, too, is determining from the economic point of view; for example, a great country may find it advantageous to obtain material from a neighbouring country rather than from within the confines of its own extended territory. The geologist locates, the mining engineer advises on practicability, and the industrialist, backed by adequate finance, seeks to develop these relevant deposits. Sound knowledge, enterprise and no little courage is demanded. The collective outcome normally is availability in reasonable relationship to world demand.

Without exception, the steel-making countries do not possess complete essential resources and must import much that is necessary. In normal times, international trade provides the necessary facilities at world prices on a reasonably economic basis. Small countries as well as large ones have successfully developed important steel industries.

To implement the foregoing it is interesting to examine a few cases and then it will be obvious, having in mind present world conditions, that it is essential to use available alloys on their intrinsic technical merits and only to the absolutely essential degree.

As regards the principal alloying elements used in the alloy steel industry, manganese ore, while widely distributed, is produced essentially in Russia, India, West and South Africa and Brazil. Nickel ore production is focused essentially on localized deposits in Canada. Chrome ore, though very widely distributed, is produced in Rhodesia and South Africa, Turkey and the U.S.S.R., and in lesser degree in Cuba, the Philippines, India, Yugoslavia and Greece. Tungsten ore is essentially produced in China, Burma and in less degree in the United States of America and South America. Molybdenum ore production is focused essentially on deposits in the United States. Vanadium ore is produced essentially in Rhodesia and South-West Africa, the United States and Peru. Cobalt ore is derived principally from the Belgian Congo, Rhodesia and Canada.

It will thus be seen that the principal steel-producing countries, the U.S.A., the U.S.S.R., Germany, Great Britain, France, Japan, Belgium, Luxembourg and Scandinavia are dependent upon the normal functioning of international trade and copious transport, particularly in the form of shipping.

Great Britain relies upon importing 30 per cent of her iron ore and the whole of her manganese, chrome, nickel, tungsten, molybdenum, vanadium and cobalt. Germany relies upon importing most of her manganese ore and the whole of her chrome, nickel, tungsten and molybdenum; she claims to recover her vanadium at home. The U.S.A. imports more than 90 per cent of her manganese ore and practically the whole of the chromium, nickel, cobalt and a substantial proportion of her requirements in tungsten. It is thus obvious that the conditions postulated in the fourth clause of the Atlantic Charter did operate even in the period between the two great wars, or how can one explain, for example, the successful iron and steel industries of Scandinavia and Belgium–Luxembourg.

One of the greatest technical achievements is the huge output of iron, and by virtue of the influence which carbon and other elements can confer readily upon it, a very wide range of properties is available. Steel may be soft and ductile, hard and of great strength, wear-resisting, rust- and acid-resisting, heat-resisting; may be of high permeability, capable of a high degree of permanent magnetism; may be non-magnetic, have a high electrical resistance, or a low coefficient of expansion. It may possess various combinations of these and other properties as required. It can be converted by added elements into any of a wide range of tool steels and steels for many special applications. These results are attained by a knowledgeable heat-treatment superposed upon a selected suitable composition.

Some fifteen elements are involved in the production of these various properties, and it will at once be apparent that millions of alloys of various compositions would need to be tested out really to put this phase of metallurgy upon a finally quantitative basis. Thus some properties may be achieved by using different proportions of different elements, and that fact, coupled with other factors operating in the world, has resulted in quite a complexity as regards the number of steels available. The obvious thing is for the producer and user in co-operation to use only those compositions which are most effective and most in sympathy with the availability of the materials.

The problems before such a collaboration are influenced by many variables. There is the peculiar combination of properties required for a particular purpose, achieved by complex compositions which, although they in practice achieve their purpose, have been found to do so by practical trial—that is, by 'trial and error' method—and it is not always easy in a steel containing a number of alloyed elements in different proportions to diagnose the extent to which amounts of each individual element contribute or to what extent the selected superposed heat-treatment is responsible for the ultimate result. Again, it can be argued that so long as the necessary mechanical and physical properties are secured, the composition and treatment are of secondary importance; this might truly be argued, were it possible by testing methods alone to ascertain completely whether the conditions for a particular service have been achieved. Laboratory tests to simulate the calls of service are valuable, but they are generally incomplete. Even the designer, try as he may, is never sure of being able to postulate completely on paper the conditions which he has to meet and then provide the means of meeting them.

Thus, by practical experimental procedure based on existing knowledge, mechanisms and apparatus are provided, built of materials which by trial are found to serve the purpose. It is, therefore, not a matter of surprise that when success has been painfully achieved by modifications here and there as dictated by circumstance, the means whereby success has been achieved are fairly rigidly adhered to. When stock is taken in a national emergency, multiplicity of types of material and of design is to be expected. The next step is to facilitate mass production by strictly limiting the number of designs and vastly reducing the number of types of material.

What has been done as regards the metallurgy of steel, particularly as regards special and alloy steels? In May 1940, the Special and Alloy Steels Committee constituted its Technical Advisory Committee with a mandate to deal with this problem. It was found that the production of the steels was governed by between two and three thousand specifications. The first step was, therefore, a meticulous study which resulted in the sorting out of the whole of the steels covered by the specifications into eighty-five categories essentially upon the basis of mechanical properties, compositions or special functions. The T.A.C. Schedule 1 to 85 did not lend itself to general publication since it was all-embracing, but it permitted the appropriate authorities and individuals to survey the interesting position thus disclosed.

The main point achieved was that it became possible to measure up needs against availability as regards the essential alloying elements. Means were found by the Steel Control, assisted by the goodwill of the industry and the consumers, to accommodate manufacture with quite reasonable success to changing conditions. Still conditions change, but in the truly indigenous British manner of adaptation to changing circumstance, the means of adaptation now exist which it may be presumed will achieve as much as is possible according to the existing conditions and needs of the moment.

The T.A.C. schedule of eighty-five categories for so many specifications was possible owing largely to the manner in which the same object was being achieved by different or slightly different compositions and treatments. Thus, as will be described, selection was possible of a relatively few appropriate compositions and treatments to facilitate mass production, but at the same time alternative steels became scheduled and so material guidance exists for change with availability as the need arises. How far can results be achieved without alloy conditions? How far can we replace nickel with chromium or chromium with nickel? How and in what circumstances are molybdenum and vanadium essential? Can we replace tungsten with molybdenum or molybdenum with tungsten? Will a modified heat treatment with a different composition give the same characteristics? A survey of the categories of the schedule assists in answering some of these questions.

In 1941 advantage was taken of the existence of the British Standards Institution to issue document *BS*970/1941, giving in the form of fifty-eight specifications the principal and most useful of the steels in the schedule covering Wrought Special and Alloy Steels for General Engineering purposes in dimensions up to 6 in. ruling section. This document was shortly followed by *BS*971, which implemented the contents of *BS*970/1941 with much technical and other useful data facilitating the successful application of the selected steels; this document sets a precedent in form. At this stage the Steel Controller issued a 'direction' through the British Standards Institution *BS*970A indicating that, in conformity with existing conditions, certain steels specified in *BS*970/1941 should in the absence of special sanctions be the steels applied in future programmes. Thus the 'En Series' of war steels entered their useful career. On March 30, 1942, a brochure was issued indexing and correlating the great mass of specifications to the steels of the Direction 970A which sought to replace them. Two remaining steps should be mentioned: *BS*970/1941 was revised and is re-issued as *BS*970/1942, and representatives of all the Services, after deliberation upon the steps already taken, issued through the British Standards Institution Document *BS*/STA5, which co-ordinates the whole of the requirements of the Services within the terms of reference with the composition and properties of the steels of the 'direction' on the basis of the En Series contained in *BS*970/1942.

This successful collective effort at unification has only been possible as a result of the firm determination of all parties to attain that which was intended. Finality in present changing circumstances is not possible, but succeeding documents under the ægis of the same authorities will, it is hoped, successfully keep up to date such essential data.

The fortunate Crusader had a superbly efficient Toledo sword of high temper; that is, the blade had a tensile strength of more than a hundred tons per square inch. This was obtained by the diffusion of carbon into wrought iron, and the steel so produced when heated above the critical point became a solid solution of carbide or carbon in iron; rapidly quenched in water from this temperature the blade was intensely hard and also brittle, but when lightly tempered by reheating to a skilfully selected temperature, material hardness was still retained but was accompanied by a remarkable toughness. Such results can only be obtained in such thin sections; if heavy pieces of such steel are quenched from the hardening temperature, the actual rate of cooling becomes so relatively slow as to allow the solid solution to break down and hardening is not achieved. Nevertheless, modern carbon steels which, different from the steel of medieval times, contain a substantial quantity of manganese, may be hardened and tempered in the form of bars of quite useful sizes with resultant considerable strength and ductility. The exploitation of such material to the greatest practical extent is most desirable at the present time.

The use of a particular composition of steel necessary for a particular application is governed by the strength and properties required and by the sectional area, or to be more correct, the 'ruling section'. If the mass is considerable and the strength required great, a rich alloy steel is essential to ensure success in hardening and therefore the possibility of superposing upon the quenched condition by tempering a desirable toughness associated with the degree of strength required.

In heavy masses where it is desired to obtain properties resulting from hardening and tempering, as much as 5–6 per cent of alloying elements is necessary, such as chromium and nickel, and these elements may be used in different proportions with a material degree of interchangeability, according to availability. Under such conditions a small proportion of molybdenum is desirable essentially to preserve higher values in resistance, when required, to the notched bar impact test and in part to reinforce the hardening properties. As the mass or section decreases, less alloy is needed, and this aspect is given quantitative guidance on alternate bases in *BS*970/1942 and *BS*971. Thus the heavy use of alloying elements should be restricted according to mass.

The remarks so far refer to the development of strength and hardness in different degree by the processes of hardening and tempering. There are a considerable number of instances where alloys used in greater quantity produce important and entirely different characteristics. 13–30 per cent of chromium and 2–20 per cent of nickel, together with lesser amounts of other elements, are necessary to produce rust-, acid- or heat-resisting steels. Large quantities of tungsten and/or molybdenum, together with material quantities of chromium, vanadium and cobalt, are used to produce high-speed cutting steels. High percentages of manganese are necessary to produce the wear-resisting properties of the austenitic manganese steel. Many other special purpose applications could be quoted. The use of such steels, owing to their high alloy content, is being carefully watched and controlled.

The problem is a considerable one: namely, how at the present time to cater for a greatly increasing demand for steels of the necessary properties, with a changing availability and a considerable deficiency in some of the essential elements. Never has a more interesting technical situation developed, for solution by scientific and technical minds.

Autocracy in science or technology is as deadly as in the political field. In these efforts within the steel industry, our work is being advanced by the friendly and enthusiastic collaboration of many minds; the co-ordination of different points of view has resulted in, and is operating, a workable procedure. Stark efficient realism is necessarily our theme.

THE TOTAL SOLAR ECLIPSE OF OCTOBER 1, 1940

THE results obtained by the joint expedition of the National Geographic Society and the National Bureau of Standards to Brazil to observe the total solar eclipse of October, 1940, are given in enviable detail in a beautifully produced monograph appearing as No. 2 in the Solar Eclipse Series of Contributed Technical Papers of the National Geographic Society. The site selected by the two organizations was at Patos, a town of 10,000 inhabitants in north-east Brazil, some 160 miles from the coast. The programme included photographing the corona in monochrome and in colour; measurements of the brightness and polarization of the corona; a spectrographic study of the flash- and coronal-spectra from 10,000 A. to 3,000 A.; measurements of sky brightness, from which the physical condition of the upper atmosphere was to be deduced; precise contact-time observations; and radio sounding of the ionosphere for the purpose of studying the effects produced by the eclipse in the upper atmosphere. Much of the apparatus taken out was specially designed for this expedition, and it must have been an anxious time when, after a clear dawn, clouds began to form at sunrise. Occasional clear patches allowed glimpses of the narrowing crescent of the sun after first contact, but during totality (8.45 a.m. local time) the sky in the neighbourhood of the sun was completely veiled, though the clouds were thin enough to allow a view of the inner corona, and an excellent flash-spectrum was obtained just after third contact. The photographic observations of the corona and the photometric measurements on the sky illumination were ruined, however, and even the radio observations, though independent of the weather, were somewhat marred by a technical mishap. However, much valuable information has been derived from those parts of the programme which could be carried through, and the monograph contains seven papers on various aspects of the results.

I. C. Gardner describes the design and construction of the eclipse apparatus, the main items of which were two corona cameras, one equipped with a rotatable polarizing screen, and two slitless concave-grating spectrographs intended to record the chromospheric and coronal spectra in the ranges 3,000–5,500 A. and 5,000–10,000 A. respectively. All the apparatus was operated by vacuum or electric lines, either automatically or by push-button control, and the exposures were made on standard aeroplane (240 mm.) roll film. Instead of using mountings which can be adjusted for future eclipses in different latitudes, cheap welded frames were made in angle-iron or steel tube, the intention being to provide the proper elevation in future by remaking the appropriate parts of the frame. Fine adjustment was provided by mounting the frames on ordinary screw jacks in concrete.

The short-wave spectrograph was operated manually when a sudden break in the clouds occurred at the end of totality, and a single first-order spectrogram 1 m. long (dispersion 2·4 A./mm.) was secured, showing the chromospheric emission lines superposed on an over-exposed Fraunhofer spectrum. Unfortunately, a mishap to a control switch on the other spectrograph prevented a simultaneous long-wave record being obtained. A contribution by C. C. Kiess gives the results obtained by measurement of the spectrogram: wave-lengths, estimated intensities and characters, origins and term combinations are listed for nearly 1,100 chromospheric lines in the region 3,227–5,398 A. The Balmer series is traced from $H\beta = H_4$ to H_{29}, but there is no sign of the ionized helium line at 4,686 A.

As in all modern astrophysical work, calibration marks were impressed on the spectrograms with the view of deriving absolute intensities for the emission lines. The intensity calibration was performed by means of a standard tungsten-ribbon lamp operated at 2,917° K. The intensity distribution in the spectrum of this lamp, as received at the focal surface of the eclipse spectrograph, was measured at 100 A. intervals between 3,450 A. and 5,350 A. by R. Stair and W. W. Coblentz, the work being described in full in one of the papers comprising the monograph. C. C. Kiess and C. J. Humphreys, in another contribution, utilize this calibration in making intensity measurements on the *b* group of Mg I in the green, on the *H* and *K* lines of Ca II in the ultra-violet, and on the Balmer lines of hydrogen. As is well known, the intensity decrement along the

Balmer series furnishes a means of discriminating between the various possible modes of excitation of the lines. From $H\gamma$ to $H\eta$ the observations agree best with the Pauli-Schrödinger formula, in which the excitation is assumed to be by direct absorption of radiation in the Lyman series; whereas from $H\theta$ to $H\varphi$, which is the limit of practicable measurements, the intensities follow closely the Menzel-Baker formula, in which the Balmer emission is assumed to be due to recombination of protons with electrons freed by photo-electric ionization of hydrogen atoms by radiation beyond the Lyman series limit.

The partial accomplishment of a very different part of the programme is described by P. A. McNally in the fifth paper of the series. The proposal here was to make accurate determinations of the times of contact by taking 260 photographs of the crescent during the partial phases. Clouds interfered with the completion of this programme, only about one half of the exposures being recorded, and only very few of these were secured within a minute of the times of contact. Nevertheless, the number of pictures taken was much greater than in any previous eclipse, and the paper shows how the observations can be satisfactorily reduced, and gives in tabular form the derived systems of corrections to ephemeris mean anomalies of the sun and moon.

The programme proposed by E. O. Hulburt was to deduce, by means of measurements of the sky brightness during the eclipse, the temperature of the upper air immediately following its illumination by full sunlight. Illuminometer measurements of the zenith sky on days previous to the eclipse had shown that the temperature during morning and evening twilight was 218° ± 15° K. for all altitudes between 20 km. and 60 km. Analysis of a few observations made during the first half of totality in an isolated patch of clear sky shows that, as was expected, the brightness at this early stage was due mainly to light scattered more than once by atmospheric particles in the umbra below 20 km. After mid-totality the clouds closed again, and made illuminometer measurements useless, since there is obviously no point in determining the brightness of the lower sides of clouds, which will doubtless be illuminated mainly by the horizon glow.

In the seventh and last paper of the monograph, T. R. Gilliland describes the radio observations, which were made for the purpose of studying the changes of ion density produced by the optical eclipse in the ionosphere. A self-contained trailer unit comprising a variable-frequency transmitter and receiver and a recording oscillograph was used at the eclipse site to record critical frequencies for the layers E, F_1 and F_2 at quarter-hour intervals on several control days before and after October 1, and at minute intervals during the eclipse. Unfortunately, a breakdown in one of the tuning condensers interrupted all recording shortly after third contact, and it was not resumed until after the eclipse ended. However, much of interest emerges from the ion densities deduced from the observed critical frequencies. In the layers E and F_1 the ionization decreased to 22 per cent of its normal value within a minute or so of second contact, whereas the F_2 ion density was still dropping at third contact and probably reached a minimum of about 50 per cent of normal about an hour after the eclipse maximum. A puzzling feature of the observations is that the recombination coefficient estimated for the E and F_1 layers depends somewhat on whether the depth of minimum or the time of minimum is considered; and a marked rise in the ion density two or three minutes before totality ended is also unexplained. The observations confirm the importance of the part played by solar disturbances in causing upper-air ionization: a distinct decrease in ion density occurred as the moon obscured a large sunspot.

Astronomers and physicists will sympathize with the members of the expedition in their bad luck with the weather, and will congratulate them on making such good use of the observational material they did manage to secure in spite of adverse circumstances.

A. HUNTER.

HENRY FAIRFIELD OSBORN AND THE AMERICAN MUSEUM OF NATURAL HISTORY

By PROF. W. K. GREGORY

ON April 8 the double event of unveiling a bust of the late Prof. Henry Fairfield Osborn and the opening of the new North American Mammal Hall took place at the American Museum of Natural History on the occasion of the annual members day. Mr. A. Perry Osborn, acting president of the Museum, presided at the meeting. In his opening address Mr. Osborn told the members of some of the effects of the War upon the Museum in the loss of men to the army and the reduced operating funds. He spoke also of the assistance the Museum had been able to give to the Government by supplying information on the geography, climate, native diseases, and so forth, of the countries to which the American armies are likely to be assigned. He then introduced to the members Dr. A. E. Parr, who succeeds Dr. Roy C. Andrews as director of the Museum.

Before the uncovering of the memorial bust, Prof. William K. Gregory made a commemorative address on "Osborn, the Scientist", of which the following is the substance:

The unveiling of the bust of Henry Fairfield Osborn and the opening of the new Hall of North American Mammals are appropriately brought together in one meeting. To Osborn's enthusiasm and unconquerable energy we owe this entire memorial building, dedicated to his friend and fellow-naturalist, Theodore Roosevelt. This building in turn forms a perfect setting for the new hall, which is filled with superb mounts of the larger North American mammals in their native haunts—beloved alike by Roosevelt and Osborn.

Osborn's scientific studies on fossil mammals began in 1877, when he and several of his classmates at Princeton, including his close friend and colleague, William Berryman Scott, made their first expedition to the Bridger Eocene basin of Wyoming. Here they discovered enough strange extinct forms of mammalian life to give them an uncontrollable urge to discover more. From this expedition sprang a long and ever-branching system of explorations, at Princeton under Scott and at the American Museum under Osborn. From the Flaming Cliffs of the Gobi Desert and the withering slopes of the Siwaliks in India, to the frozen soil of Alaska, many a "valley of dry bones" has heard the clang of the explorer's pick and yielded up its dead. Under the spell of the prophet the dry bones came together and thus it happened that in our temple of science many an ancient leviathan rears his mighty frame before us.

All this and much more was set in motion by Osborn, who often went into the field himself; but he always gave full credit to his captains and other men whom he had inspired and trained in the science of palæontology. In such a roll of honour he would undoubtedly himself inscribe the names of Matthew, Granger, Brown, Lull, Forster-Cooper, Andrews, Frick. And among the younger men of to-day are several to whom he was happy to entrust the future of palæontology.

As a student of Huxley and a disciple of Darwin, Osborn developed a broad interest in many branches of the biological sciences, as shown in his general work, "The Origin and Evolution of Life"; but his most intensive work was in the field of mammalian palæontology. His first important memoir was a systematic revision and study of the fossil teeth and jaws of the tiny mammals which were the contemporaries of the dinosaurs. Quite early (1888) began his interest in the evolution of mammalian molar teeth.

In his later years Osborn undertook to prepare a series of great monographs on the histories of the families of horses, titanotheres and proboscideans, or mastodons and elephants. In view of the heavy demands on his time from many other directions, his achievements in this field were truly enormous. Two of his great works (on the titanotheres and the proboscideans) stand out among the 940-odd entries in his bibliography and will be consulted as long as palæontology remains a living science.

Osborn's greatness as a man of science depended upon his greatness as a man. His vision, enthusiasm, conviction, persistence, persuasiveness, tolerance and restraint made him successful both as leader and investigator. Indeed, those of us who were close to him as a scientific worker immediately felt and responded to his benign influence as a man.

Dr. James R. Angell, in his personal tribute to Prof. Osborn, said that Osborn is immune to any serious peril of lack of appreciation, although only time will approximate a just evaluation of his accomplishments. His greatest contributions live on in the great institution which he served so long and so brilliantly. As himself an eminent scientific worker, constantly contributing to push forward the boundaries of knowledge, by his example inspiring the members of his staff and men of science everywhere to similar achievements, not less than by his administrative ability and his talent for interesting generous benefactors in the support of this enterprise, he left an indelible imprint upon his time. He put the American Museum of Natural History into the very forefront of the great scientific agencies of the period, stimulating throughout the nation a new understanding of the educational power of such institutions, while serving this great metropolitan community by opening ever wider to its citizens the unrivalled wealth of its superb collections. In all this undertaking he worked side by side with his loyal colleagues in the organization—*primus inter pares.*

In this process his own work came at times under severe attack, for while the well-authenticated fact is reasonably immune to assault, the inferences based upon it, the generalizations arising out of the effort to orient it amid other data and principles, unavoidably lead to corrective interpretation at other hands. The man of sincere scientific spirit is never seriously irked by this experience, provided he be not essentially misrepresented, for much of this kind of rough and tumble is inevitable in all progress. Osborn certainly had his full share of this type of conflict and would unquestionably accept with good grace such corrections and modifications of his own views as with the passing of the years the development of scientific knowledge may involve. Nor does it follow that because his own particular views may in certain cases fail to prevail, his contribution is in any way to be held lightly. Quite the contrary is the fact. Such approximation to truth as the human mind can ever attain is always the result of the clarifying increments made by successive generations of thoughtful men.

Men possessing such a combination of qualities as those of Osborn are all too rare. The good administrator is a familiar figure, the eminent man of science has many exemplars, even the man of science of deeply religious convictions, such as Osborn held, is by no means unknown; but it is extremely rare to find these gifts combined in one man, and when they are conjoined with a remarkable charm of personality and sterling integrity of character, we are confronted with one of the most unusual of the benefactions of a generous providence.

The bust of Prof. Osborn was unveiled by his daughter, Mrs. Jay Coogan. The bronze is of heroic size mounted on a rectangular plinth of polished Bois Jourdan marble. Below the name the following inscription is carved:

> "For him the dry bones came to life
> And giant forms of ages past
> Rejoined the pageant of the living."

Dr. Harold E. Anthony, head of the Department of Mammals, described the long, almost twenty-year period of planning the new Hall of North American Mammals. The new hall is much more than a collection of mammals. It is a series of vistas into the ecology of North America. It offers to the visitor a grand tour of outstanding regions of the continent. The mammals have the limelight, but the exhibits portray the geology and the botany of places which are properly the home of the animals as well as noteworthy for many other features.

The hall would attract attention if it had no mammals at all in it. It is a hall of realities, not of fancies. Each group is an actual reconstruction of a definite place, at a given date and time of day, and no detail is left to guesswork. The accessories not only look natural, they are natural. These very items were found at the place where the group was collected.

Mr. Newbold Morris, president of the Council of the City of New York, spoke of the value of the Museum in showing the earth in its past history and bringing before us again the lives of animals and peoples long gone. "If you spend enough time here you begin to place less value on your own life or the lives of those who are very close to you, because you realize you are only part of a never-ending stream. . . Every one of us is only part of a long process and here we get a feeling that perhaps human hatred and human passions are not so important. This museum, like our city, represents an ideal, something which we are always reaching for and will never attain, but we are secure in the happiness that we are still reaching for it. . . . Hatreds and passions will disappear and some day, perhaps, we will know what it is to live in a world without passion and fear."

The new Hall of North American Mammals, although far from completed, is yet an imposing example of the blending of many arts, many sciences, and the most modern methods of museum architecture, exhibition and lighting. It is 140 ft. in length by 73 ft. in width and built in the form of an 'I' with parallel aisles flanking each side of the central corridor, which extends the length of the hall. The habitat groups are recessed along the corridor and at both ends. The lighting represents the result of careful study to relieve eye-strain and to provide a restful atmosphere, with the illumination directed towards the exhibits and away from the visitor.

The backgrounds of the exhibits present a panorama of the North American continent, from Ellesmere Land, 700 miles south of the North Pole, to Mexico, and from New York State to the west coast of Alaska, with the mammals characteristic of each region. The skilled preparation of both backgrounds and specimens was the work of many artists and taxidermists under the direction of Dr. James L. Clark, head of the Museum's Department of Preparation.

The achievement of the Hall itself was due to Dr. Anthony's continuous and enthusiastic efforts, to the sympathetic understanding and aid of President F. Trubee Davison, and to the co-operation of the officials of the City of New York. The magnificent animals were collected and presented by friends of the Museum, and when all groups are installed there will be a complete series of the most characteristic mammals of the entire continent of North America. The finished groups include the Alaska brown bear, the largest carnivorous land mammal in existence, the bighorn sheep, white (mountain) sheep, Grant caribou, muskox (collected by Admiral Peary), mountain goat, Osborn caribou, Alaska moose, grizzly bear and mountain lion (puma). Nineteen groups remain to be installed, eight of these to be opened in the near future, including the bison, wapiti, Virginia deer, jaguar and various small mammals, which are also to be represented in the hall.

INTERNATIONAL TABLE OF STABLE ISOTOPES

THIS Table, together with the Fifth Report of the Committee on Atoms, was last published, in Paris, by the Union Internationale de Chimie just before the occupation of France. After that event Prof. E. Briner of Geneva very kindly offered to undertake the correspondence necessary to continue the work of the Committee. With his help I was ble, as chairman, to draw up a Sixth Report which submitted to him for publication early in 1941. Later in that year he informed me that unfortunately he had been unable to arrange for its publication, and requested me to draw up a modified report rought up to date for 1941–1942. This I did, and n February 1942 he wrote that I might soon expect he proofs of this. I have heard nothing from him nce, and as I think further delay would be unforunate, the report is appended. There has been very little published on the subject since it was drawn up and, so far as I have been able to ascertain, the other members of the Committee approve of all the lterations embodied in it.

F. W. ASTON.

Trinity College,
Cambridge.
Oct. 5.

Sixth Report of the Committee on Atoms of the International Union of Chemistry

Chairman: F. W. Aston. *Members:* N. Bohr, O. Hahn, W. D. Harkins, F. Joliot, R. S. Mulliken, M. L. Oliphant.

Owing to the impossibility of publication during 1941, this report covers double the normal period. The following changes in the Table of Isotopes are recommended:

Helium. Evidence has been obtained by means of the cyclotron that a stable isotope of mass 3 exists in Nature[1]. The abundance is very small and is estimated at about 10^{-7} per cent.

Sulphur. The parentheses indicating doubt in the existence of the very rare isotope 36 are to be removed.

Nickel. Two complete electrometric analyses have now been published, by Straus[2] and Valley[3]. Their results are given below together with those obtained in the original photometric observations[4]:

Mass numbers	58	60	61	62	64
Aston (1935)	67·5	27·0	1·7	3·8	?
Straus	62·8	29·5	1·7	4·7	1·3
Valley	67·4	26·7	1·2	3·8	0·88

Valley's work is approved by Bainbridge. His figures are in better agreement with the photometric results, and also with the chemical atomic weight, than are those of Straus. Both observers agree that 61 is 1·3 times more abundant than 64. This is in good accord with the mass spectra previously obtained by Dempster[5] and also with the original ones of Aston (re-examined) upon which the previous figures were based, but contradicts the evidence of the parabolas from which Lub[6] deduced that 61 is "with regard to 64 as 1 : 10". Valley's figures are now adopted.

Cobalt. In consequence of doubts expressed on many grounds as to the existence of a stable isotope 57, Mitchell, Brown and Fowler[7] have analysed $CoCl_2$ with a mass spectrometer. Their results show that 57 cannot be present even to 1 in 30,000 of 59. As in mass spectrometry evidence of absence is much more cogent than that of presence, cobalt is now to be regarded as a simple element.

Molybdenum. Electrometric measurements on this element have been carried out by Valley[8]. The following percentages, which he considers accurate to one per cent, are recommended:

Mass numbers	92	94	95	96	97	98	100
Abundances	14·9	9·40	16·1	16·6	9·65	24·1	9·25

They show a satisfactory small divergence from the photometric ones of Mattauch and Lichtblau, adopted in the previous report, and the original ones of Aston, and lie roughly between the two.

Rhodium. The rare isotope 101 of rhodium is subject in considerable degree to the same objections as that of cobalt above mentioned. It will therefore be regarded as doubtful, and given in parentheses, until further experimental evidence is available.

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[1] Alvarez, L. W., and Cornog, R., *Phys. Rev.*, **56**, 379 (1939).

[2] Straus, H. A., *Phys. Rev.*, **59**, 430 (1941).

[3] Valley, G. E., *Phys. Rev.*, **59**, 836 (1941).

[4] Aston, F. W., *Proc. Roy. Soc.*, A, **149**, 396 (1935).

[5] Dempster, A. J., *Phys. Rev.*, **50**, 98 (1936).

[6] Lub, W. A., *Proc. Roy. Soc. Amsterdam*, **42**, 253 (1939).

[7] Mitchell, J. J., Brown, H. S., and Fowler, R. D., *Phys. Rev.*, **60**, 359 (1941).

[8] Valley, G. E., *Phys. Rev.*, **57**, 1058 (1940).

OBITUARIES

Prof. David Waterston

THE death of Prof. David Waterston on September 4 at the age of seventy-one removed one of the distinguished anatomists of the Edinburgh School and a familiar figure for the past twenty-eight years in the life of the University of St. Andrews. After graduating in arts in the University of Edinburgh he took the M.B., C.M. in 1895, the F.R.C.S. (Ed.) in 1898 and the degree of M.D. with a gold medal for his thesis in 1900.

In anatomy Waterston found his life's work and he became lecturer and chief assistant to Sir William Turner, and was one of the ablest of the many anatomists trained by that great master. In 1909 he was appointed professor of anatomy in King's College, University of London, which post he held until 1914 when he succeeded Prof. Musgrove as the second occupant of the Bute chair of anatomy in the United College of the University of St. Andrews.

He entered with zest into the life of the University, for many years was adviser of medical studies, served the University Court as a representative of the Senatus during 1929–35, and during 1930–40 was the representative of the University on the General Medical Council.

Under his direction the Department of Anatomy in St. Andrews has undergone progressive development, and he had the satisfaction of raising it to a high standard of efficiency.

A man of science, Waterston was precise in expression, critical of statements ; his powers of observation were always keen and astute, his eager mind stretching out after more and more facts. Much of his technical skill was directed to making the science of anatomy a living one, and we have testimony to this in his volume "Anatomy in the Living Model". He was joint editor of "The Edinburgh Stereoscopic Atlas of Anatomy", was one of the contributors to Cunningham's "Text-book of Anatomy" and published many papers upon anatomical, embryological and anthropological subjects. He was especially interested in prehistoric man and enriched the museum by the collection he made of his handiwork.

In addition to such specialized study he retained a keen interest in clinical medicine and found scope for his ingenious mind in the problems which presented themselves in the work of the James Mackenzie Institute. After the death of Sir James Mackenzie the Institute found in Waterston a staunch and able leader, while as one of its research workers he conducted experiments on himself in order to elucidate the mechanism of pain—a contribution of the highest value.

To those who were associated with him in his work his distinctive personality and influence were a source of continual interest, encouragement and stimulus, and to junior members of his staff he was invariably courteous and never too busy to listen to their problems and to help them by advice.

He was not only a diligent member of many of the committees which are necessary in a university, but also gave valuable service as a member of the Council of St. Leonards and St. Katherines Schools, and since 1939 he had been a member of the Town Council of St. Andrews.

He enjoyed social occasions and in the pursuit of his favourite recreation golf, he played many keen matches in the Royal and Ancient Competitions. Few knew the anatomy of the golf swing better than he did and to the end his short game lost none of its accuracy.

Many have sorrowfully paid tribute to the memory of one who will be much missed. D. R. DOW.

Prof. P. A. Hillhouse

WHEN one looks back on the career and life of Prof. Hillhouse, formerly professor of naval architecture in the University of Glasgow, who died on September 28, at the age of seventy-three, one cannot but realize that his success was due to the combination of great ability in his chosen profession of naval architecture and his personal charm.

As naval architect to the Fairfield Company he was responsible for the design of many famous vessels, but probably the Canadian Pacific *Empress* liners will be for a long time remembered as representing his most notable achievements. To appreciate fully his gifts as a designer one had to work with him. Always ready to investigate the most exacting conditions set down by the shipowners, he was never led into adopting a doubtful policy ; no one could have carried out all the preliminary design work with greater care, and one always felt that, once his decision was made, it was the best possible.

The inevitable discussions that sometimes occur between owners and builders found him quite unperturbed, and his calmness and cheerful good humour never deserted him. He was rightly considered an authority on the launching of ships, but, as in all else, he did not think himself to have better ideas than others.

On the powering of ships he had no superior, and he had a remarkable gift for making the fullest practical use of the published work of those engaged in model experiment tanks. In fact, he had no equal in mastering quickly the essential points of any available information.

As professor of naval architecture in the University of Glasgow, a position he held for twenty-one years, Prof. Hillhouse's lectures covered a very wide range. Some of his less competent students may possibly have found it difficult to keep pace with him, but his kind and understanding nature made him tolerant; and he was regarded with affection by all who passed through his classes.

Prof. Hillhouse would have made a first-class consultant, had he chosen to set up in practice. The legal cases in which he figured as technical adviser were brilliantly conducted, as he possessed the clear vision so necessary in this particular class of work

To those of us who were fortunate enough to know Prof. Hillhouse and his work, his death came as a severe blow, but no one of us can fail to have profited by knowing him and his methods.

WE regret to announce the following deaths :

Flight-Lieut. A. N. David, of the Indian Forest Service, on October 16, aged fifty-three (on active service).

Prof. Alfred Hettner, formerly professor of geography in the University of Heidelberg.

Prof. G. H. Ling, formerly professor of mathematic in the University of Saskatchewan, aged sixty-eight

Prof. K. N. Moss, O.B.E., professor of coal and metal mining in the University of Birmingham, on October 20, aged fifty-one.

NEWS and VIEWS

General Smuts and a New World Order

IT would be out of place to attempt to assess here the value of the address to members of both Houses of Parliament which was delivered on October 21 by General Smuts. Suffice it to put on record that he surveyed the war situation, paying a tribute to the people of Great Britain, but for whose exertions from 1939 onwards "this world of ours might have been lost for a thousand years, and another dark age might have settled down on the spirit of man". This survey led him to a consideration of the real nature of the present struggle as a deadly conflict for the rights and liberties of the individual and for the ideals of man's ethical and spiritual life. He concluded with some thoughts on the future and on the social and international order at which we are aiming. Our ideas on this subject at the close of the War of 1914–18 were much too vague and the concept of a League of Nations too ambitious. This time we have accepted the name of "the United Nations", which, if more moderate in outlook, seems more promising of practical effect. The Atlantic Charter also marks an important step forward in the international ordering of the world. Certain broad principles of social policy have also been agreed upon, and the Mutual Aid Agreement between the United Nations provides the beginning of international assistance of nations in need. In this field much of the work and the machinery of the League of Nations is still of value.

General Smuts summed up his view of the future in words which cannot be bettered: "We are passing beyond the ordinary politics and political shibboleths. . . . Without feeding on illusions, without nursing the impossible, there is yet much in the common life of the people which can be remedied, much unnecessary inequality and privilege to be levelled away, much commonsense opportunity to be erected as the common birthright and public atmosphere for all to enjoy as of right. Health, housing, education, decent social amenities, provision against avoidable insecurities—all these simple goods and much more can be provided for all, and thus a common higher level of life be achieved for all. As between the nations, a new spirit of human solidarity can be cultivated, and economic conditions can be built up which will trike at the root causes of war, and thus lay deeper oundations for world peace. With honesty and sincerity on our part it is possible to make basic eforms both for national and international life which will give mankind a new chance of survival and of progress. Let this programme, by no means too mbitious, be our task, and let us now already, even n the midst of war, begin to prepare for it. And may Heaven's blessing rest on our work in war and in peace."

Rutherford Memorial Lecture of the Physical Society

IT is altogether fitting that we should praise amous men, and should hold in memory those whose abours have been directed to great and unselfish nds, and who have attained results which will serve as a beacon to future ages. It is difficult for his contemporaries accurately to assess the contributions o knowledge of a lately lost leader—we stand too near his achievements to see them as clearly as we would—but there are few judgments more likely to and the test of time than that which puts the name of Rutherford alongside those of Newton and of Faraday. His insight, his simplicity and directness of mind, his almost uncanny instinct for securing the right line of advance and refusing to be diverted along side-tracks, his power of attaining epoch-making results by relatively simple means—all these are qualities which rank him with the great discoverers.

The Physical Society is to be congratulated on its decision to found a biennial Rutherford Memorial Lecture, and it is by a peculiarly happy chance that the date for the delivery of the first Lecture should fall in the year of, indeed within a few weeks of, the day of the tercentenary anniversary of Newton's birth. The Lecture will be delivered by Prof. H. R. Robinson, professor of physics in the University of London (Queen Mary College), in the lecture theatre of the Science Museum on November 6, at 4.30 p.m., and will deal with Rutherford's life and work to the end of the Manchester period. Three outstanding events in Rutherford's scientific career fall within this time—two belong to the Manchester years—and there are few better fitted, by knowledge and sympathy, to give an address which shall be worthy alike of the subject and the occasion than is Prof. Robinson.

Chemotherapy and Tuberculosis

NOT the least of the late Sir Walter Fletcher's services to medical research was his wise encouragement of research in chemotherapy. His prescience has been fully justified by the notable advances made in that subject in recent years. The conquest of a disease in former days was of epoch-making significance. The world rang with the triumphs of Ehrlich when he prepared '606'. Yet within a few years puerperal fever, gonorrhœa, cerebro-spinal fever with a mortality of 50–80 per cent, lobar pneumonia and the streptococcal infections have been shorn of their former terrors by the timely use of drugs of the sulphanilamide group. The medical profession and the general public have received these boons of the research laboratory gratefully, it is true, but with extraordinary composure, when it is remembered what a heavy toll these diseases took in the past and how many years were spent in therapeutic investigations upon them. Humanity is perhaps dazzled by the successes achieved, too dazzled to pay the due meed of recognition to the pioneers of this work.

It is possible that the long-wished-for remedy for tuberculosis may eventually come, through chemotherapy. Recently, 'Promin', the didextrose sulphonate of diaminodiphenyl sulphone, a member of the sulphonamide group, has been found by Feldman and Hinshaw at Rochester, U.S.A., to be active against the tubercle bacillus both *in vitro* and *in vivo*. Prof. W. H. Tytler, of the Welsh National School of Medicine, Cardiff, has made some experimental studies with 'Promin' (Thirtieth Annual Report for the year ended 31st March, 1942, of the King Edward VII Welsh National Memorial Association. Report of the Director of Research. Pp. 46). His results so far show that it is the most effective chemotherapeutic agent for the tuberculous guinea pig yet tested. Unfortunately, the toxicity of the drug in the high continued dosage necessary has hitherto prevented its full therapeutic application to human beings, although in local application to superficial tuberculous lesions it is efficacious. This objection may eventually be overcome, possibly by combining the administration of the drug with that of an antigenic serum or by other modifications of its toxic properties. At all events the discovery of this drug represents an important advance and may be the prelude to greater things.

War-time Lessons for Peace-time Health

THE Minister of Health, Mr. Ernest Brown, speaking at a meeting of the Cambridge University Medical Society on October 21, said that the operation of war-time services is providing a background against which the Ministry is working out ideas for future developments in public health. As regards the Emergency Hospital Service, Mr. Brown said that the old conception of independent general hospitals to serve all purposes has gradually been replaced by a more co-operative scheme in which different hospitals in an inter-dependent group have special centres for different purposes. Problems of the necessary financial arrangements, including the functions of hospital contributory schemes, of the precise place in the schemes of the local authorities, of what central control will be necessary in a hospital area including the districts of several local authorities, and similar details, remain to be worked out in detail.

Referring to the Ministry's plans to introduce mass miniature radiography to discover cases of incipient tuberculosis, Mr. Brown said that a technical committee is preparing advice for the tuberculosis authorities, to which the machines now on order will be supplied, on how the sets can be used to the best advantage. This committee is also making arrangements to train teams to work the sets and considering proposals for recording results of examinations. The procedure will be to take miniature chest radiograms of a section of the population. It is expected that about 4 in every 100 will show abnormalities on the miniature film, and a full-sized chest radiogram will be taken of these and a clinical examination made. Thus the early case is found and treatment can be begun under the best conditions for success. Though the technique of mass radiography should prove a valuable new weapon for the fight against tuberculosis, it is not a panacea; it does not supersede the established technique but rather permits its wider and more hopeful application.

Food Value of the Potato

CONTINUED success in safeguarding the essential food supply of Great Britain must largely depend on our ability to use still more home-grown foods, particularly potatoes, in place of imported energy foods. On a calorie basis, each four tons of home-grown potatoes used in Great Britain releases the shipping space otherwise occupied by a ton of wheat. Further, potatoes yield 50 per cent more calories per acre than wheat, despite the greater water content of the former crop (78 per cent against 38 per cent for bread). The components for which potatoes are nutritionally notable are iron, vitamin C and the vitamins of the B-complex. One pound of potatoes provides 330 calories, equivalent to 5 oz. of National bread or 11 per cent of the day's requirement for a moderately active man; 3 mgm. of iron, 25 per cent of the day's requirement and equivalent to that of two eggs; 100 I.U. of vitamin B_1, 20 per cent of the requirement and equivalent to that of 5 oz. of bread. One pound of freshly lifted potatoes contains 135 mgm. of vitamin C, which is almost twice the day's needs; the average C content of potatoes makes a pound equivalent to 3 oz. of orange juice. Potatoes are rich in factors of the vitamin B-complex; 1 lb. is equivalent to ½ pint of milk or 11 per cent of the day's needs of riboflavin; to 4 oz. of meat or 36 per cent of the requirement of niacin or nicotinic acid. A pound of potatoes also probably contains as much vitamin B_6 and folic acid as 1 lb. of National bread, and as much pantothenic acid as one pint of milk.

The following table shows the average composition of potatoes:

Moisture	78%		
Protein	1·2%		
Carbohydrate	16·2%		
Calories	70	per 100 gm.	
Calcium	8 mgm.	,, ,, ,,	
Iron	0·7 ,,	,, ,, ,,	
Vitamin B_1	40 I.U.	,, ,, ,,	
Vitamin C	9 mgm.	,, ,, ,,	
freshly lifted	30 ,,	,, ,, ,,	
before Xmas	12 ,,	,, ,, ,,	
after Xmas	6 ,,	,, ,, ,,	
Riboflavin	0·07 ,,	,, ,, ,,	
Nicotinic acid	1·4 ,,	,, ,, ,,	
Vitamin B_6	0·15 ,,	,, ,, ,,	tentative values
Pantothenic acid	0·3 ,,	,, ,, ,,	
Folic acid	0·12 ,,	,, ,, ,,	

At the present time the amount of potatoes purchased per head per day is less than 1 lb. This represents less than 13 oz. of edible potato. In Germany and in Ireland, more than 2 lb. a day are eaten as a national average.

Farming in Great Britain

"WAR Farming and After" was the title chosen by Lord Cornwallis for a paper to the Farmers' Club at the centenary meeting held in London on October 6. Using the first-hand knowledge gained as chairman of the Kent Agricultural Executive Committee, Lord Cornwallis outlined the problem facing British farming at the outbreak of war and showed how an ill-prepared and impoverished agriculture has risen to the occasion and achieved the remarkable result of 5 million acres gained for the plough in three years. Not only has this area been converted from grass or waste into arable, but also the standard of farming has been improved, and "the lovely land of England is beginning to look as if someone cared for it". The gain of human food has not been secured at the cost of the vitally important milk supply, for the dairy herds have been maintained in a remarkable manner largely on home-grown foods. The organization that has brought this about—the county executive committees, their technical advisers, and all who worked on the land—has done a great service to Great Britain, and there is every indication that progress will continue. With farming on its feet and pulling its weight, all connected with the land have their minds fixed on the future of the industry after the present emergency has passed. The Government is pledged to maintain the stability of home farming until a permanent post-war policy can be put in action. This, as Lord Cornwallis said, implies a measure of control and the insistence on a certain standard of efficiency.

Earthquakes in Guatemala

THE United States Coast and Geodetic Survey in co-operation with Science Service and the Jesui Seismological Association, on a basis of instrumental reports from 23 seismographic observatories, ha determined the epicentres of recent earthquakes in Central America. The first was on August 6, 1942 at 23h. 37m. U.T., and the second on August 8, 1942 Both had epicentres near latitude 14·4° N., longitude 90·9° W., which is to the south-west of Antigua

The first earthquake had a depth probably greater than normal, and the second was an aftershock of the first. Both shocks happened in an acknowledged seismic zone.

Exhibitions of Photography in Science and Industry

THE Association of Scientific Workers is arranging an exhibition, "Photography in Science and Industry", to be held during November in the rooms of the Royal Photographic Society at 16 Princes Gate, London, S.W.7. The exhibition will be opened by Sir Robert Watson Watt, president of the Association, under the chairmanship of Mr. D. McMaster, president of the Royal Photographic Society, on October 31 at 3 p.m. The field covered by the exhibits will be wide and have particular reference to the war effort, including work on machine movement analysis, radiography of castings, etc., mapping and surveying, mass examination for tuberculosis, crystallography, astronomy, nuclear physics, template making, etc. Exhibitors include the Ministry of Information, technical branches of the three Services, individual technicians and the large photographic firms. During the last decade a number of specialized photographic techniques of application to industrial problems have been developed, but although the results, published in technical journals, have become familiar to many workers, the number of people employing photography as an industrial tool is still small. It is hoped that the Exhibition will do much to familiarize engineers, scientific workers, medical men and others with the methods used by specialists, and suggest their use as a direct contribution to the war effort in fields other than those illustrated. During the course of the exhibition, lectures will be given on various applications of photography; the Royal Photographic Society is arranging a symposium on industrial radiography to be held on November 21 at 2.30 p.m., and the Society's Hurter and Driffield Memorial Lecture will be delivered by Dr. S. O. Rawling on "Sensitometry since Hurter and Driffield", on November 28 at 3 p.m.

An exhibition of photographs and apparatus showing "Photography's Part in the War" will be opened by the Right Hon. Lord Brabazon of Tara, at Kodak House, Kingsway, W.C.2, on November 3. The exhibition will be open to the public at 2 p.m. on that day, and on weekdays 9.30–5.30, Saturdays 9.30–12.30, for three weeks. Admission is free. Among the subjects illustrated are aerial reconnaissance, applications of photomicrography, high-speed photography, slow-motion cinematography, industrial radiography, photo-elastic analysis, mass radiography against tuberculosis, and the production of Airgraph letters.

Exhibition of Soviet Life in War and Peace

SOVIET medicine and health services will be strongly featured in the National Exhibition of Soviet Life in War and Peace which will be held at the Wallace Collection, Hertford House, London, W.1, during November 8–22. Ten national organizations, in addition to the Ministry of Information, have co-operated in the production of the Exhibition, which will be opened by M. Maisky, the Soviet Ambassador, and Sir Edwin Lutyens, the president of the Royal Academy. It is designed to give a comprehensive picture of the life of the Soviet people from 1917 onwards. The great achievements which have been made will be recorded, and there will be displays of Soviet costumes, books, pottery, etc. In dramatic contrast to the sections devoted to peace-time developments will be those illustrating the epic feats and tremendous sacrifices made by our Russians. There will be daily film shows, music recitals and lectures. Among those contributing to the programmes are Prof. A. V. Hill, Dr. Joan McMichael, Dr. Walton, Profs. H. Levy and C. H. Reilly. Full details can be obtained from the Secretary, 150 Premier House, Southampton Row, W.C.1.

Chemical Society Research Fund

HITHERTO, the Research Fund Committee of the Chemical Society has met in December of each year to consider applications for grants from the Research Fund. In view of present conditions, however, the Council has decided that for the present, applications for grants shall be considered as and when received. Forms of application for grants are obtainable from the General Secretary. All those who have received grants, accounts of which have not been closed, are reminded that reports should be sent to the General Secretary not later than Monday, November 16.

The Night Sky in November

NEW moon occurs on November 8d. 15h. 19m. U.T., and full moon on November 22d. 20h. 24m. Conjunctions during the month are as follows: Nov. 7d. 13h., Mercury in conjunction with the moon, Mercury 3° S.; Nov. 10d. 10h., Mercury in conjunction with Mars, Mercury 1·1° N.; Nov. 23d. 15h., Saturn in conjunction with the moon, Saturn 3° N.; Nov. 27d. 12h., Jupiter in conjunction with the moon, Jupiter 3° N. Occultations of stars brighter than mag. 6 are given below:

	d.	h.	m.	
Nov.	14	20	38·1	29 Capricorni
„	16	21	19·7	83 Aquarii *m*
„	17	22	59·2	27 Piscium
„	18	00	36·2	29 Piscium
„	20	01	30·5	ν Piscium

Mercury can be observed in the morning at the beginning of the month. Venus and Mars are too near the sun to be favourably observed. Jupiter can be observed soon after 10 p.m. and Saturn shortly after sunset. The Leonid meteor shower is due on Nov. 13–14, the radiant point being at R.A. 10h., Dec. +22°, and the Andromedes on Nov. 18–24; the radiant is near R.A. 1h. 40m., Dec. +43° about the middle of this period, west of γ Andromedæ, but neither of these showers which were once quite conspicuous displays has shown much activity in recent years.

Royal Society of Edinburgh: New Officers

AT the annual meeting of the Royal Society of Edinburgh held on October 26, the following officers were elected: *President*: Prof. E. T. Whittaker; *General Secretary*: Prof. James P. Kendall; *Secretaries to Ordinary Meetings*: Prof. R. J. D. Graham and Prof. W. M. H. Greaves; *Treasurer*: Sir Ernest Maclagan Wedderburn; *Curator of Library and Museum*: Dr. John E. Mackenzie; *Councillors*: Prof. Edward Hindle, Prof. J. R. Matthews, Sir Arthur Olver, Dr. David Russell, Dr. Robert Campbell, the Right Hon. Lord Cooper, Prof. E. W. H. Cruickshank, Sir J. Donald Pollock, Mr. Stanley Cursiter, Dr. Douglas Guthrie, Prof. J. W. Heslop Harrison, Mr. Andrew W. Young.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Frictional Properties of Bearing Metals

MOST bearing alloys consist of a matrix of a soft metal in which are distributed uniformly small crystals of a harder metal. Such a structure has been found by long experience to possess the most satisfactory mechanical, frictional, and low-wearing properties. It is usually supposed that the hard constituent carries the load, while the soft matrix serves to distribute the pressure uniformly and to embed abrasive particles in the lubricant[1]. The hard phase also stands out in relief from the soft phase at room temperature, and such a surface of minute hills and valleys is often said to possess desirable lubricating qualities. On account of the higher thermal expansion of the softer constituent, Kyropoulos[2] states that the latter is able to take the load at higher temperatures, that is, under running conditions. On the other hand, the opinion has been expressed[3] that a single soft metal constitutes as efficient a bearing as the conventional structure of hard crystals in a soft matrix. In actual practice, of course, a variety of different bearing alloys are used depending on the conditions of sliding. When the conditions are severe, as at high speeds and high and varying loads, only certain types of alloy structure can be used with success, and the homogeneous metal is unsatisfactory. It does therefore appear that a heterogeneous structure possesses definite advantages for bearing metals.

Some recent frictional studies have brought to light the interesting result that a thin film of a soft metal on a backing of a harder metal gives a lower friction against a steel slider than for the two types of metal separately. The friction was measured on the Bowden-Leben apparatus[4] in which the frictional drag on a small slider, held and restrained by a bifilar suspension of high frequency, is measured while a flat lower surface is moved under it. Such an arrangement (described more fully in the original reference) enabled the rapid fluctuations in the friction during slow sliding to be followed in detail. Table 1 gives the results for a small hemispherical slider of steel, 2 mm. in diameter, sliding on a lower plate of copper before and after a thin film of a soft metal had been wiped out on it by hand. The friction on the soft metal alone is given for comparison.

TABLE 1.

Upper slider: steel hemisphere, 2 mm. in diameter. Load, 400 gm. Speed of sliding, 0·003 to 0·006 cm./sec.

Lower surface	Average coefficient of friction at room temperature (20° C.)
Copper	0·3 to 0·7
Lead	0·4 ± 0·1
Film of lead wiped on to the copper surface	0·03 to 0·08
Cadmium	0·3 ± 0·1
Film of cadmium wiped on to the copper surface	0·09 ± 0·005
Tin	0·5 ± 0·1
Film of tin wiped on to the copper surface	0·15 ± 0·01

The values were usually the same at 100° C., with the exception of the layer of tin on copper, which broke through quite readily with a corresponding increase in the friction. On other metals the results were essentially similar, but if the hardness of the metal backing became too great, the film of soft metal was easily penetrated and the friction rose to the value obtained on the hard metal. The lubricating action of the soft metal would appear to be analogous to that of a viscous grease in a bearing or mud on the road. That is, a small area of contact is achieved on the hard metal substrate, while the soft metal at the area of contact causes the adhesion and deformation resistance to be low, and, in fact, acts as a viscous fluid lubricant. It will be noted that the coefficient of friction may become considerably lower than that observed for a well-established boundary lubricant such as oleic acid, where $\mu = 0{\cdot}11$ for such surfaces.

The influence of the thickness of the film of soft metal on the value of the coefficient of friction has not yet been investigated in detail. The results obtained so far show quite clearly that the value of μ for thick films of lead on copper approaches the lead value, while very thin layers become easily penetrated to give the friction of the hard metal. There is thus a minimum friction observed for a certain thickness of the softer metal layer, which in the case of lead on copper at temperatures around 100° C. may become as low as $\mu = 0{\cdot}025$. The values mentioned in Table 1 for lead, cadmium and tin were obtained for thicknesses of the soft metal produced by simply rubbing it over the copper surface a few times. In general, it was always found that the coefficients of friction were in the order, lead < cadmium < tin, for such layers of these metals. It is clear, however, that differences in the lubricating efficiency for a particular film would depend on a number of factors, among which may be mentioned the film hardness, shear strength, degree of hardening, and self-annealing and the presence of non-metallic molecular layers on the surface.

Additions of a boundary lubricant reduced slightly the already low values of the friction of these thin films. Corrosive lubricants, such as oleic acid or an oxidized oil, actually increased the friction after a short time due to the removal of the film of soft metal by chemical attack. Although these experiments described have all been carried out at slow speeds of sliding, a few experiments have shown that thin layers of lead on copper can function as lubricants at speeds approaching those in an actual bearing.

These results suggest that in a heterogeneous bearing metal the soft phase wipes out over the hard phase during sliding. Under severe conditions in the bearing, when both the fluid and the boundary lubricant films break down, this thin layer of metal may function as a lubricant for a brief interval until normal lubricating conditions are re-established. Experiments with a lead-copper alloy have supported this hypothesis. Table 2 shows the results obtained for an ordinary lead-copper alloy containing 24 per cent lead.

TABLE 2.

Upper slider, load, and speed as before.

Lower surface	Average coefficient of friction	Temperature
Lead-copper alloy (24% Pb)	0·3 ± 0·05	20° C.
Lead-copper alloy after 50 slides in the same track	0·08 ± 0·01	100°
The same track cooled down to room temperature	0·08 ± 0·01	20°

Similar results have been obtained with other bearing metals with the same type of structure.

A comparison of Tables 1 and 2 shows fairly clearly that, although at room temperature no amount of lead detectable by its lubricating action comes out of the alloy, at 100° C. lead is wiped out and considerably reduces the friction to the same order of magnitude as for a film of lead rubbed on to the copper by hand. Since the superior bearing qualities of lead-copper alloys become evident at high loads, speeds and temperatures, it seems probable that their good anti-seizure properties are the result of lubrication by a thin lead film when metal to metal contact occurs under conditions of lubrication breakdown. It is thus important that the structure of the alloy should be such that the lead can flow to the surface from underneath, and that it should not be distributed as isolated aggregates. The importance of the availability of lead in lead-bronze bearing alloys has been emphasized by Wood and Harrison[5], and our experimental results confirm their expressed opinion on the type of structure to be aimed at in a high-duty bearing metal.

The above is a record of work carried out for the Department of Scientific and Industrial Research; it was submitted to the Department on September 3, 1940, but, at that date, publication seemed undesirable. Copies were sent, however, to interested parties at that time.

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[1] See, for example, Bassett, H. N., "Bearing Metals and Alloys" (Arnold and Co., London, 1937), Chapter 3.

[2] Kyropoulos, S., *Refiner and Nat. Gas. Mfr.*, **19**, 85 (1940).

[3] Goodman, p. 81 in ref. 1.

[4] Bowden, F. P., and Leben, L., *Proc. Roy. Soc.*, A, **169**, 371 (1939).

[5] Evans, H. L., and Harrison, S. T., *Chem. and Ind.*, **58**, 122 (1939). Wood, E., and Harrison, S. T., private communications.

Electrical Properties of Polystyrene

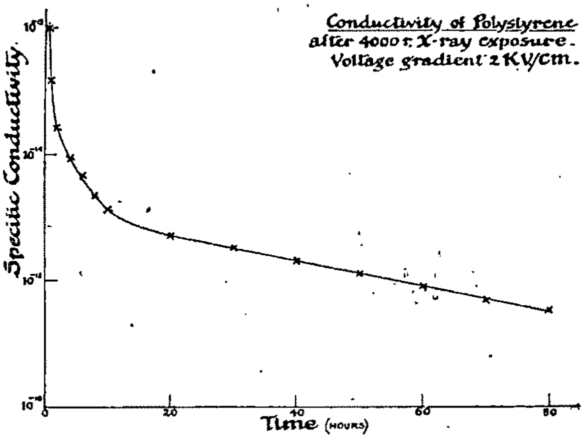
THE value of polystyrene and of certain other organic plastics as dielectrics for high-frequency apparatus is well known. The power factor for polystyrene at frequencies of 10^6–10^7 c./s. is of the order of 0·0002, a figure much lower than that for most insulators.

Other properties of this material render it very suitable for insulating purposes, notably its low water absorption, and resistance to cracking.

We have recently investigated the direct current conductivity of this same substance with a view to its use in instruments for radiological work. A cylindrical condenser was used for this purpose, with a closely fitting cap to exclude air ionized by cosmic rays, and the charge was observed by an electrometer after standing for a period of the order of 1–2 weeks. Great care was taken to keep the surface of the insulator clean and dry.

The result found for an average sample of polystyrene was a specific resistance of 3×10^{20}. Surface leakage could not be eliminated completely, and this figure is, therefore, a lower limit. It is, however, some 1,000–10,000 times the values that have been published from time to time, and greatly in excess of the value for ordinary insulators, such as glass, ebonite, etc.

When X-rays are passed through the substance its resistance falls; the amount of fall depends on the intensity and the duration of the radiation, but may be by a factor of 10^8 or more. Moreover, it has been found that the conductivity so induced lingers for a very considerable time after the X-rays have been cut off. The accompanying curve shows the effect during a period of 80 hours following a brief exposure. At the end of this time the material is still far from back to its original state.



These qualities of a material now used widely for electrical work are likely to become of increasing importance. It is the purpose of this note simply to record the results, but it is clear that they are of decided physical significance, and their full interpretation in terms of the structure of the material is likely to be of great interest.

I am indebted to Dr. J. E. Roberts for introducing this valuable material to radiological work.

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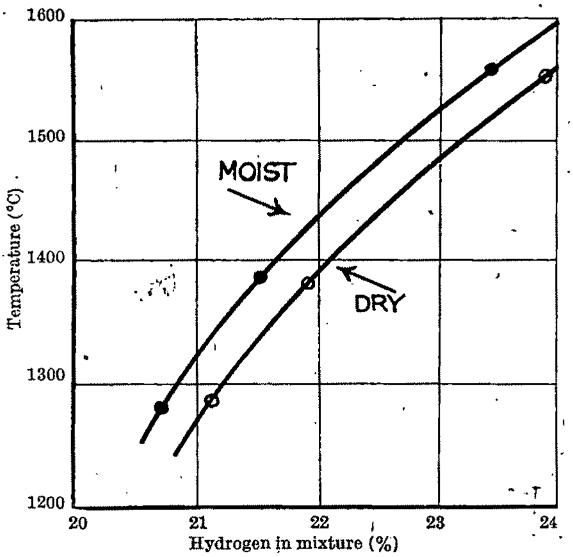
Oct. 7.

Influence of Water Vapour on Flame Gas Temperatures

THE influence of water vapour upon the combustion of carbon monoxide is well known, but its influence upon the combustion of hydrogen is not so well known.

It has been shown that flame gases resulting from closed-vessel explosions of moist mixtures of hydrogen and air contain less latent energy than those resulting from explosions of dry mixtures[1]. We have just completed a series of temperature measurements in the flame gases from moist and dry hydrogen - air mixtures which show that this is so also in the case of open flames. These measurements, which were recorded by means of thin quartz-covered platinum wires, are shown in the accompanying figure. It will be seen that for any given hydrogen content the moist flame gas temperature is 40–50° C. higher than the dry flame gas temperature, and this in spite of the fact that the calculated temperature for the moist mixture is about 15° C. lower than that for the dry mixture.

David and Pugh previously reported that the temperature attained by an uncoated platinum-rhodium wire immersed in carbon monoxide flame gases was higher when the mixtures were moist than when dry[2]. As it is now known that an abnormal amount of dissociation obtains in flame gases and that the dissociated gases combine on a platinum



surface[3], it was thought desirable to repeat these experiments using quartz-covered wires. The results, however, were very similar in that they showed similar temperature differences for moist and dry mixtures.

It will be remembered that, in the determining of flame-gas temperatures by the sodium line reversal method, water vapour is usually introduced into the inflammable mixture along with the sodium salt. For this and other reasons[4] we regard the sodium method as unreliable.

W. T. David.
J. Mann.

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Oct. 9.

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[1] David and Leah, *Phil. Mag.*, 18, 311 (1934), and David, *Proc. Inst. Mech. Eng.* (in the press).

[2] Nature, 140, 1098 (1937).

[3] Nature, 145, 896 (1940).

[4] *Engineer*, 172, 186 (1941).

Intravenous Glucose Tolerance Curve

In the usual intravenous glucose tolerance test, the blood-sugar is measured at intervals after a single rapid (2–3 min.) injection of glucose, and plotted against the time, as in the accompanying diagram. The resulting curve has hitherto been called hyperbolic, parabolic, and so on; but on plotting the data of some 35 tests on psychotic patients (performed in collaboration with Dr. D. Russell Davis, to whom grateful acknowledgement is made), I find that the points are closely fitted over all, or nearly all, the time period 5–90 min. by an exponential curve of the form

$$y = y_0 + Be^{-kt}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where y is the blood-sugar, t the time measured from the mid-time of the injection, and y_0, B and k are constant for any particular test. Equation 1 applies also to numerous tests taken from the literature[1]. For example, the diagram is based on a test by Jörgensen[1]; the circles represent the experimental values, while the solid curve represents equation 1 with the following values for the constants: $y_0 = 30$ and $B = 300$ (mgm. per 100 ml.), $k = 0{\cdot}0214$ (min.$^{-1}$). The fit of the curve is even better in many of our own tests, but none extended beyond 90 minutes.

During the first 5 minutes or so, y falls much more quickly than equation 1 allows (y was greater than 385 at $1\frac{1}{2}$ min. in the test illustrated). Immediately after the injection, glucose diffuses rapidly out of the blood-stream[2]; and it is now suggested that when equation 1 begins to apply, the glucose concentrations in plasma and extravascular fluid have become roughly equalized. If this be so, and the glucose distribute itself evenly through a volume V_G of body fluid, then as a rough estimate

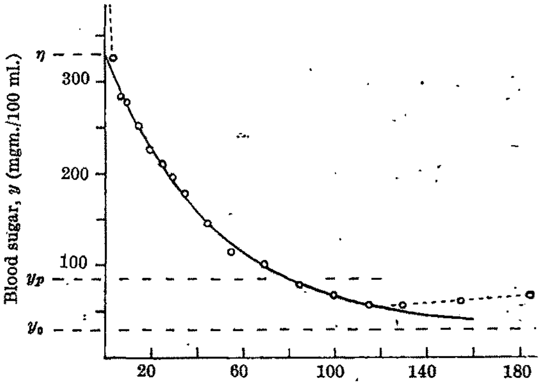
$$V_G = G/(\eta - y_p), \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where G is the amount of glucose injected, y_p is the pre-injection blood-sugar, and η the value of y given by equation 1 when $t = 0$ (see diagram). I have calculated V_G for a number of tests, and found it to be correlated with the surface area (A) and the body-weight (W) of the subjects. Mean values of V_G/A and V_G/W are given below for three groups of subjects: I, psychotic; II, normal (? children—tests by Crawford[1]); III, normal adult (tests by Lozner *et al.*[1]).

	No. of subjects	Mean V_G/A (l./m.^{2})	Mean V_G/W (ml./100 gm.)
I	12	7·15	21·3
II	9	—	19·4
III	15	6·94	19·3
		Mean V_T/A	Mean V_T/W
IV	31	7·15	18·8

For comparison, row IV shows the result of some recent determinations[3] of the thiocyanate distribution volume as calculated by the uncorrected formula[4] (V_T). This is believed roughly to represent the extracellular fluid[4,5] together with red cell water. The table suggests that V_G is of the same order as V_T, namely, about 20 ml. for each 100 gm. of body weight, not 70 ml. as for the total body water. This is consistent with the hypothesis that, after intravenous injection, glucose diffuses rapidly into the extracellular fluid and red cells. That there should be a low or negligible concentration inside the tissue cells is reasonable: at least, this contention is supported by sugar analyses in the muscle of the cat[6] and rat[7]. Also, from infusion experiments on the eviscerated cat, Burn and Dale[8] concluded that glucose spreads through about 17 ml. of fluid per 100 gm body-weight.

If it can now be assumed that when equation 1 is obeyed, plasma- and extracellular fluid-glucose are in equilibrium, then the rate of fall of blood-sugar ($-dy/dt$) will be proportional to the rate of remova



Intravenous glucose tolerance test (20 gm. glucose). Circles: experimental values (data of Jörgensen [1]). Solid curve: $y = 30 + 300\,e^{-0{\cdot}0214t}$

of glucose by the tissues. The latter will then bear a linear relationship to the blood-sugar, since, on differentiating (1),

$$-dy/dt = ky - ky_0. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This interpretation of equation 1 is in accord with the finding that the rate of utilization of glucose by extrahepatic tissue of the cat increases linearly with the blood-sugar[9]. Indeed, if the penetration of glucose into the cell involves an "active process"[6] which limits the rate of utilization, equation 3 might be a reflexion of the kinetics of this process.

It is remarkable that the many influences, including an increased insulin secretion[10], to which the blood-sugar is subject, should not distort the curve. Equation 1 is even obeyed during part of the 'hypoglycæmic phase' (see diagram). In the end, however, the regulating mechanisms[10] come into play, and the blood-sugar begins to rise.

This work is being continued, and I hope to report it in detail elsewhere.

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Oct. 1.

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[1] Jörgensen, *Acta Med. Skand.*, **65**, 116 (1926-27). Crawford, *Arch. Dis. Child.*, **13**, 69 (1938). Ross, *Arch. Dis. Child.*, **13**, 289 (1938). Tunbridge and Allibone, *Quart. J. Med.*, **9**, 11 (1940). Lozner, Winkler, Taylor and Peters, *J. Clin. Invest.*, **20**, 507 (1941).

[2] Pijoan and Gibson, *Amer. J. Physiol.*, **121**, 534 (1938). Kurakowa, *Tokohu J. Exp. Med.*, **10**, 64 (1928). Tunbridge and Allibone, *Quart J. Med.*, **9**, 11 (1940).

[3] Stewart and Rourke, *J. Lab. Clin. Med.*, **26**, 1383 (1941).

[4] Crandall and Anderson, *Amer. J. Dig. Dis.*, **1**, 126 (1934).

[5] Lands, Larsen and Cutting, *Proc. Soc. Exp. Biol., N.Y.*, **41**, 606 (1939). Kaltreider, Meneely, Allen and Bale, *J. Exp. Med.*, **74**, 569 (1941).

[6] Lundsgaard, *Upsala Läkarefören. Förh.*, **45**, 143 (1939).

[7] Cori, Closs and Cori, *J. Biol. Chem.*, **103**, 13 (1933); in conjunction with Eppright and Smith, *Amer. J. Physiol.*, **121**, 379 (1938).

[8] Burn and Dale, *J. Physiol.*, **59**, 164 (1924).

[9] Soskin and Levine, *Amer. J. Physiol.*, **120**, 761 (1937). Lundsgaard, Nielsen and Örskov, *Skand. Arch. Physiol.*, **81**, 20 (1939).

[10] Discussed by Soskin, *Physiol. Rev.*, **21**, 140 (1941).

Vitamin C from Green Tomatoes

Loss of vitamin C by mincing a natural product and thus setting free ascorbic acid oxidase has been shown to occur in orange peel (Lampitt and Baker[1]), and in cabbage and swedes (Pyke[2]; Lampitt, Baker and Parkinson[3]). Experiments in this laboratory have shown that the destruction of the vitamin is especially rapid in green plant tissue (for example, 80 per cent loss in 1 minute in shredded lettuce). We, therefore, thought it of interest to compare the rate of loss of the vitamin in green and in red omatoes.

The results summarized in the accompanying table how that when tomatoes are pulped, as would occur in mincing for the preparation of chutney, 92 per ent of the vitamin may be destroyed in 7 minutes in green tomatoes, whereas in ripe red tomatoes only 27 per cent is lost. Pyke's results on the importance of avoiding too fine a state of subdivision of reen vegetables have been confirmed. Unripe tomatoes chopped into medium-sized pieces lost nly 18 per cent on standing overnight, while similar tomatoes coarsely sliced lost only 11 per cent in the same period. Pulped green tomatoes put immeiately into vinegar diluted 1 in 10 with water lost 80 per cent on standing overnight. The pH of the pulp in the diluted vinegar determined on the glass electrode was 3·7. The pH of ripe tomato juice is usually below 4·5 and that of the flesh is below 5. In unripe tomatoes the pH of the juice and flesh may be much less acid or even slightly alkaline. The pH of the skin appears to remain alkaline throughout ripening. The oxidizing enzymes which are probably responsible for the destruction of the vitamin are concentrated in the skin and flesh and practically absent from the juice.

EFFECT OF DIFFERENT TREATMENTS USED IN PREPARATION OF CHUTNEY ON VITAMIN C CONTENT OF UNRIPE AND RIPE TOMATOES.

	Unripe			Ripe
Time	Pulped	Chopped	Coarsely sliced	Pulped
(min.)				
1	89	—	—	—
2	72, 74	—	—	—
3	—	—	—	94
7	8	—	—	73
12	—	—	—	71
15	5	—	—	—
17½	—	—	—	67
30	—	—	—	63
60	—	—	—	50, 60
(hours)				
2	—	—	—	29
20	—	82	89	10
20	20*	—	—	—

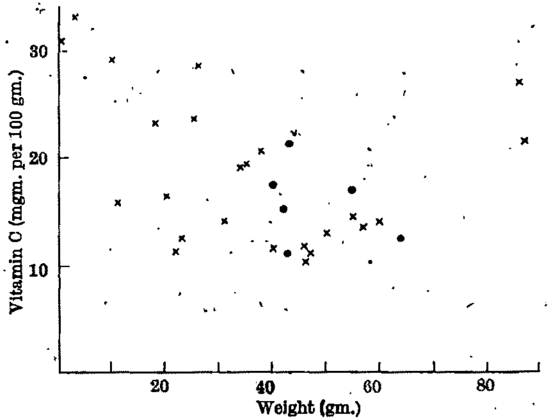
Results quoted as percentage of initial value, as determined in replicate portions of same tomatoes by 2:6 dichloroindophenol titration.

Result marked * obtained on pulped tomato added within 1 minute of pulping to vinegar diluted 1 in 10. Allowance has been made for the loss (about 11 per cent) of vitamin C during the minute required for pulping.

The table is compiled from results obtained on a number of different tomatoes tested at different times. In two instances two different tomatoes were tested for the same period of time, the results being given separately (thus, 72 and 74).

Experiments are being carried out on the effect of ripening on the vitamin C content of tomatoes. So far, the results indicate that the vitamin C content does not increase appreciably during ripening. Data on a number of tomatoes given in the accompanying graph show no significant difference between the average vitamin C content of ripe tomatoes (indicated by dots) and unripe tomatoes (indicated by crosses). Moreover, small tomatoes contain at least as high a concentration of vitamin C as large tomatoes. This applies even to tiny fruit weighing less than 1 gm. Experiments are also in progress on the effect of high concentrations of sugar such as are used in making chutney. Preliminary results indicate that these do improve the stability of the vitamin.

The conclusions we draw from these results (which are to be reported in detail later) are that, to avoid



Vitamin C content of tomatoes

loss of vitamin C: (1) no tomatoes should be discarded merely because they are small or unripe; (2) unripe tomatoes when being made into chutney should not be cut too finely, and should be put immediately into strong vinegar to which sugar should be added without undue delay.

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JOAN G. ORGAN.

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[1] NATURE, 149, 271 (1942).

[2] NATURE, 149, 499 (1942).

[3] NATURE, 149, 697 (1942).

Estimation of Moisture in Living Tissue

IN view of the statements made in recent letters[1] in NATURE regarding the estimation of moisture by distillation with an immiscible liquid, and the relationship of such figures to those obtained by oven drying, the results we have obtained recently may be of interest.

Comparison has been made of the apparent 'moisture content' of dehydrated vegetables by several methods: (*a*) distillation with toluene (Dean and Stark[2]), (*b*) vacuum oven at 70° C. and less than 50 mm. pressure, (*c*) hot-air oven at 115° C., and (*d*) steam oven at 96° C.

The results will be reported in full elsewhere, but in general they bear so little resemblance to each other as to give serious cause to doubt whether the figure for 'moisture' returned in many analyses has any significance unless the method is specified. The Dean and Stark method gave results higher than the vacuum oven, but lower than the hot-air oven, and for carrots, onions and cabbages it gave no indication of reaching a constant figure even after thirteen hours distillation. Potatoes and parsnips, on the other hand, gave a constant figure fairly quickly. The loss of weight in the vacuum oven became constant in about 5–8 hours for all vegetables, the other ovens requiring 8–16 hours for onions, parsnips and potatoes, but showing little approach to constancy with carrots and cabbage. This latter effect appears to be due to changes in the structure of the plant materials during the heating, for they change considerably in colour in both the hot-air and steam ovens, although not in the vacuum oven. The standard error of the mean was lowest in the vacuum oven, higher in the steam oven, and much higher in the hot-air oven.

As examples of the variations found the following figures may be quoted.

	'Moisture' by			
	Hot-air oven (115°)	Steam oven (96°)	Vacuum oven (70°)	Toluene distillation
Carrots	15·08	8·52	5·45	11·2
Cabbage	16·05	12·04	5·44	11·1
Potato (v. Factor)	11·98	10·37	10·50	11·5

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R. L. REID.

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University of Sydney.
June 29.

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[1] Holt, P. F., Callow, H. J., NATURE, 148, 755 (1941); Warne, L. G. C., *ibid.*

[2] Dean and Stark, *J. Ind. Eng. Chem.*, 12, 486 (1920).

Anemotaxis in Soft-skinned Animals

LITTLE is known about the effect of wind on the orientation of animals on the ground. Some insects resting in exposed places will often head upwind[1]. The newt *Triton tæniatus* walks in the same direction as an artificial air current[2]. Riders and airmen are familiar with the fact that horses tend to stand with their backs to a strong wind.

Experimenting with slugs (*Agriolimax reticulatus, Arion subfuscus* and *hortensis*) on a turning table, it was observed that after several minutes turning they would always bend their heads against the direction of the passive rotation, regardless of whether they were originally facing towards the centre or the periphery. It was assumed that this reaction was caused by the air moving over one side of the body. Animals were then exposed on a stationary table to artificial air currents coming from a tube. (1) If the current was so gentle as to be scarcely perceptible on the observer's cheeks, the tentacles of the animals, after an initial retraction, expanded towards the source of the current, the animal frequently raising its head from the table and testing the current with all four tentacles. (2) However, a strong air current coming from one side, best directed a little from above and behind, led to the contraction of the nearer tentacle or even the whole head, and to a subsequent sharp turning of the animal to face down wind. The most likely mechanism for both reactions depends on the wind bending the animal, and its tentacles in particular[1]. According to the intensity of the wind, propioreception of the bending force may then induce the positive or the negative reaction. This assumption is supported by the observation that a much stronger wind is needed to cause the bulky *Limax maximus* to turn away than is required for the smaller species.

Similar reactions as in the slugs may be observed in *Helix hortensis* and *aspersa,* earthworms and maggots (of Calliphora, Drosophila).

The positive anemotaxis described may be important for the animal's olfactory orientation. The negative reaction may reduce the rate of desiccation or lead the animal to shelter.

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University College, London,
at Rothamsted Experimental Station,
Harpenden, Herts.
Sept. 29.

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[1] Fraenkel and Gunn, "The Orientation of Animals", pp. 258 and 26 (Oxford, 1940); Kalmus, NATURE, 150, 405 (1942).

[2] Czeloth, H., *Z. vergl. Physiol.*, 13, 74 (1930).

The Public Schools in Great Britain

I SHOULD like to make a few comments upon th recent communication by the number of distinguishe men of science discussing the Public Schools in Grea Britain[1].

I do not know how much first-hand and up-to-dat knowledge the signatories have of the working of th Public Schools; in the course of the communication the lay down a number of general propositions without pro ducing evidence in support of them—for example that men brought up in the Public School traditio are "out of touch with modern social realities", an that the teaching of science under the condition existing in these Schools "tends to become an esoteri cult, isolated from social purpose". Those who hav had long experience of teaching in Public School either boarding or day or both, will not, I think, find reason to agree with either of those very broad and unsupported statements? In one other matter too the signatories are definitely misinformed; that is, where they say that the proposed offer of places in the Public Schools to boys previously trained in public elementary schools has been imposed upon the Public Schools by their financial necessities. How they can venture upon this statement without knowledge of the finances of the Schools is not clear. I would simply say two things—first that a large number of the Public Schools are in a flourishing state, and have no need to make up their numbers in that or any other way; and secondly, that anyone who is acquainted with a school balance-sheet knows well that the admission of a proportion of boys with public assistance would not save the finances of any school, if they were in at all a serious condition.

I suggest that no good purpose is served by general assaults of this kind; they are mere blows in the air. The Public Schools have as many strong points and as many weak points as any other educational institution of human contriving; but the headmasters believe that the Schools have something of value to offer to the nation, and they are anxious that this offer should be made available to all British parents who desire to make use of it for their boys, irrespective of their means. We believe that we can render this wider service best if we are allowed to retain our spiritual and educational independence. If any or all of the signatories would like to meet the Committee of the Headmasters' Conference for a further discussion of these or any other questions that may arise out of their manifesto, we should be delighted to make arrangements for that purpose. Much unnecessary misunderstanding might be avoided and real progress towards the common object might be achieved, if groundless general charges could be abandoned and an effort made to grasp the problem on the basis of facts as they are, and not vague suppositions.

Spencer Leeson.

(Headmaster of Winchester College;
Chairman of the Headmasters' Conference.)

The College, Winchester.
Sept. 20.

[1] Nature, 150, 351 (1942).

Role of Protozoa in the Activated Sludge Process

The importance of Protozoa in determining the condition of the sludge has been reported by a number of workers and, more recently, the special significance of Vorticella has been emphasized by Pillai[1, 2] and Reynoldson[3]. Further detailed study has revealed the special role of the genus Epistylis, of which not less than six species have been found to be actively associated with the installations in India. These forms flourish in the aeration chambers, forming fluffy masses attached to the sides of the aeration tanks.

During aeration, the Epistylis, which number at least 16,000 per ml., get largely dispersed and thus come into direct contact with the colloids of the sewage which they collect and carry down in the form of flocs. Experiments with isolated forms have shown that, in this action, the Epistylis are at least twice as efficient as the Vorticella and many times more so than all the other forms put together.

The exact mechanism of flocculation is still somewhat obscure. The Protozoa carry a negative charge which is of the same sign as that of the colloids of sewage; they do not secrete any enzyme possessing any marked clotting action excepting on milk. They have, nevertheless, a direct action on sewage colloids in a manner resembling, but more efficient than, that of chemical flocculents.

Parallel studies with activated sludge as well as the equivalent suspension of mixed Epistylis (with the associated bacteria) have shown that the latter accounts for more than 70 per cent of the reduction in 4 hr. oxygen absorption, albuminoid and ammonia nitrogen observed in the former. About 80 per cent of the total nitrification also takes place in presence of Epistylis. Besides concentrating nitrogen in the sludge, the Epistylis cells themselves are quite rich in nitrogen, containing more than 8 per cent dry weight.

Other observations may be summarized as follows:

Prolonged aeration, especially without any inflow of raw sewage, leads to the steady disruption of the protozoan cells and even their ultimate disappearance. This condition, which is associated with the black or 'burnt out' sludge, shows that steady inflow of raw sewage is necessary for the development and active functioning of Protozoa.

With reduced air supply, the protozoan cells tend to diminish in numbers. The little sludge that is left is not reactive and does not settle readily. It gets filled with gases formed by bacterial action and eventually floats up. The phenomenon of 'bulking' which is often noticed under such conditions can thus be explained.

The reversion of the sludge observed either on prolonged standing or during sludge digestion is a drastic form of the above phenomenon, the protozoan cells first floating up, then getting disrupted and finally digested by the bacteria.

Even under conditions of adequate aeration, the presence of certain other forms of life interferes with functioning of the Protozoa and hence the purification. An outstanding example of this is the invasion of the Chironomus larvæ[4], which, under certain conditions, enter the tank in large numbers. These attack the Protozoa, especially those of the Epistylis sp., using the slimy colonies for the formation of their characteristic protective tubes and for their food. As the result of this, the functioning of the process is completely paralysed; and until the larvæ are completely destroyed and the plant re-started, there is no purification to be seen.

Some preliminary studies on the origin of the Epistylis sp. have shown that they are derived from the soil and that, though originally present in very small numbers, they multiply rapidly on aeration. Once established in the tank, they stay on and continue to function until they are destroyed by one or other of the agencies mentioned above.

It would thus appear that the start as well as the efficient functioning of the activated sludge process is mostly dependent on Protozoa which are responsible, directly or otherwise, for not only sludge formation but also the attendant oxidation changes.

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Aug. 25.

[1] Pillai, S. C., *Current Sci.*, **10**, 84 (1941).

[2] Pillai, S. C., *Indian Med. Gazette*, **77**, 118 (1942).

[3] Reynoldson, T. B., Nature, **149**, 608 (1942).

[4] Swaminathan, N., *J. Indian Inst. Sci.*, **12A**, 142 (1929).

MIGRATION OF LEPIDOPTERA

LARGE-SCALE movements of butterflies have long attracted attention, as when in A.D. 1100 it was recorded, appropriately enough in a "History of Calamities", that swarms of butterflies were seen passing from Saxony to Bavaria. In 1508 "an innumerable swarme of whit butterflyes coming so thick as flakes of snow" was noted at Calais. It is clear that dense flocks, such as were common in the towns along the south coast of England in 1939–40, are not the result of modern conditions. The keen interest of Dr. C. B. Williams has led to much close study of the subject, on which an important paper has recently been published*. Dr. Williams claims that these movements are not a mere exodus from an area of food scarcity to a land of plenty, but a real migration in the sense that they are comparable with the familiar to and fro seasonal movements of birds. Evidence to this effect is particularly striking in the case of *Danaus plexippus*, the Milkweed butterfly or Monarch. This well-known species, of North, Central, and South America, occurs in different races with different, though overlapping, geographical distribution. The northern and southern races undertake large migrations, the central one does not. The northern race, *p. plexippus*, appears to have spread over a large part of the globe, and is the one which is occasionally captured in England. Its movements have been closely studied in the south-eastern United States, and it is clear that there is a definite northward movement in the spring, the last butterflies leaving Florida when the mean temperature rises above 75° F., and arriving in the north (reaching well into Canada) after the mean exceeds 50° F. There is definite evidence of their absence from Florida in the summer: they begin to return with corresponding temperatures.

Along the Pacific coast their behaviour has for some time been notorious, for their over-wintering sites are well known in California. The places chosen are dense groups of trees, preferably evergreens; almost every suitable locality is favoured, and the butterflies congregate at the same spot year after year in dense masses; these places are the termini of the return southward migration. The vexed question of whether the specimens taken in England have flown across the Atlantic or have travelled on ships cannot yet be decided. There is a record of several specimens caught by an officer of a ship outward bound from Glasgow; they were playing round the rigging about two or three hundred miles from British shores. But no records of large flights seen on the open sea, such as have been made for Pieridæ and the familiar Painted Lady, are to hand for *plexippus*, nor have they been recorded by lighthouse-keepers like some other migrants. Evidence of return migration for some other species is accumulating and is particularly clear in the case of *Dione vanillæ*: good evidence is increasing for nine other species, including the Silver Y moth, *Plusia gamma*. Dr. Williams discusses the evolutionary difficulty of understanding how the instinct to migrate is perpetuated if outward movements occur regularly without return flight. It is probable that the more closely the question is studied the more evidence will come to hand of return flight, and Dr. Williams says, "I can still point to no butterfly in which the absence of a return flight has been established beyond reasonable doubt".

The direction of these migratory flights is not primarily connected with the direction of the wind, for diagrams in which every recorded flight is plotted as an arrow head along points of the compass show little correlation with prevailing wind. It is concluded that the orientation of individuals flying in a cross-wind shows that they do appreciate, and allow for, wind direction, but there is no evidence that the wind determines the direction of any migratory flight. Nor can the direction be associated with the position of the sun: "When one has seen a migration continue steadily in one almost compass-true direction for several weeks on end, at all times of the day and in all weathers except perhaps heavy rain, it is difficult to believe that the direction of the sun's rays can have any importance." Very remarkable is an observation from Lake Ontario: a flight of *D. plexippus* was seen by an observer, fishing in Port Bay, a narrow southward arm of the lake. The butterflies were going south but at a short distance south of the observer they made a sharp left turn, crossed the bay, a distance of about a quarter of a mile, then made a right turn and headed south again.

Experiments to ascertain whether migrants appreciate, or orientate themselves in relation to, a magnetic field produced no evidence. It is not necessary, to establish the occurrence of a migration, that the butterflies should pass in noticeable swarms; the important point is the steady passage of numbers in one direction. Evidence of a migration was produced by observing about twenty butterflies passing in twenty minutes over a front of about one hundred yards. Such a movement, however, needs expert watching and repeated observation. It is thus quite possible that more evidence of return migration can be obtained. At the other end of the scale are snowstorm migrations in which the insects are too numerous to be counted even on a short front. In one flight of the African skipper *Andronymus neander*, it was estimated that five hundred per minute were crossing on a front of twenty-two yards. Attempts have been made to treat butterflies like migrating birds by marking and releasing many at a time. So far it has not been done on a scale large enough to give results, for extremely few recoveries have been made at any distance. Statistically, however, much can be learnt from the rate of disappearance of the marked individuals from the place where they were marked. Interesting evidence that migratory movements are due to widespread factors is provided by a statistical study of correlation between the movements in America and Europe of the well-known Striped Hawk moth (*Celerio lineata*) and the Painted Lady (*Vanessa cardui*). It appears that there is a tendency for large migrations to occur simultaneously in both continents. Similarly, within the British Isles there is some correlation between movements of different species of immigrants: thus *Plusia gamma* is usually abundant when *Vanessa cardui* is.

The destruction of migratory butterflies on a large scale by birds has often been recorded, and the dismembered wings of *Pieris brassicæ* were frequently noted in many parts of England during 1940.

The Insect Immigration Committee of the South-Eastern Union of Scientific Societies is responsible for the collection of evidence of movements, and more help is much needed. Only by the continued detailed study of large masses of data can many vexed questions be decided.

G. D. Hale Carpenter.

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* Studies in the Migration of Lepidoptera. By Dr. C. B. Williams, Dr. G. F. Cockbill, M. E. Gibbs and J. A. Downes. *Trans. Roy. Ent. Soc. Lond.*, 92, 101–283.

PASCAL TERCENTENARY CELEBRATION

IN 1642 Blaise Pascal, a Frenchman, invented the first calculating machine. The tercentenary of this event, which has had such a profound influence upon applied mathematics and physics, should appropriately have been celebrated this year in Paris. In order that the date should not pass unnoticed, a small committee was formed, under the chairmanship of Dr. L. J. Comrie, to arrange a commemorative luncheon followed by an exhibition of calculating machines. Other members of the committee were an eminent Frenchman of science now in Great Britain, Mr. W. Desborough and Mr. R. S. Nilsson, a Swedish engineer. The celebration was held on October 19 at the Connaught Rooms, London. The 120 guests who attended the luncheon ncluded those who design calculating machines, hose who make them, those who use them, and several members of the Fighting French, including an official deputation from General de Gaulle's headquarters.

After the toasts "The King" and "La France Combattante", the chairman recalled that it was in he year of Galileo's death and of Newton's birth hat Pascal invented the first calculating machine. A replica of this machine, made by Mr. Nilsson, stood on a table before him. Mr. Nilsson had also made a replica of the first English calculating machine, made by Samuel Morland in 1666, which was on show n the exhibition room. Many of those present, Dr. Comrie continued, would know of the great tercentenary held in Edinburgh in 1914 to commemorate the discovery of logarithms by Napier. Had it not been for the War, the French would certainly have eld a celebration on a similar scale in honour of Pascal. It was found that two people present, Prof. . Arnold Brown and Mr. F. E. Guy, had also attended the Napier tercentenary celebrations.

Dr. Comrie next welcomed the many distinguished rench men of science and representatives of the ighting French. He mentioned particularly Mme. Weill, a former associate of Mme. Curie, and Prof. Cathala, who had travelled from Scotland for the ccasion. The Norwegian Government and the Swedish Legation were also officially represented—reminder of the Swedish engineers Scheutz, Odhner, undstrand, Fridèn, Rudin and others, who had ontributed to the evolution of calculating machines.

Dr. Comrie then called on Prof. S. Chapman, resident of the Royal Astronomical Society, to ropose the toast "Blaise Pascal—the inventor of the st calculating machine", saying that Prof. Chapman had a special claim to propose this toast, since in his pacity as professor of mathematics at the Imperial ollege he had been one of the pioneers in introducing he study of calculating machines and numerical ethods into academic courses, and had also introduced them with conspicuous success into his own eophysical and other researches. Prof. Chapman's ddress is printed on p. 508 in this issue.

The reply was by Prof. René Cassin, Commissaire ational à la Justice et l'Instruction Publique de la rance Combattante. He thanked the committee, on half of the French in Great Britain, for their enterprise in arranging this celebration in honour of Pascal. e stressed the versatility of Pascal's genius: at e age of nineteen, when he invented the calculating achine—essentially a practical instrument—Pascal was already well known in the realm of pure mathematics. His perseverance with this invention helped one to appreciate more fully the character of Pascal. He had to fight not only ill-health but also the ignorance of his time, for his conception far outstripped the mechanical experience and ability of those to whom the work was entrusted. It was not until Pascal had made more than fifty models that he achieved his final design.

The invention of the calculating machine illustrated Pascal's extraordinary creative imagination, allied with mathematical genius and precision, and tempered with critical penetration. These qualities were characteristic of the man throughout his life. Prof. Cassin spoke of Pascal's conviction, also candidly expressed in his letter to Queen Christine of Sweden, that learning was greater than the power of princes—"Toute notre dignité consiste en la pensée. Travaillons donc à bien penser : voilà le principe de la Morale". It was stimulating to remember this defence of liberty of thought at a time when political tyrants tried to turn men into machines incapable of thinking, forcing upon those in their power their fanatical ideas. The spirit of Pascal was an inspiration of those who strove to restore to France her freedom.

Prof. D. R. Hartree, whose task was to propose a vote of thanks to the speakers, asked to be allowed to include Dr. Comrie in his remarks, saying that the success of the gathering was in great part due to his chairmanship. He was glad of the opportunity of paying his own tribute to Pascal, not only as the inventor of the calculating machine but also as the worthy representative of the spirit and genius of the French people.

After the luncheon a small exhibition, which was open to the public, was held in an adjoining room. Various types of hand and electric calculating machines and models were shown, and demonstrators explained their working and applications to visitors. Two short lectures were given, one by Dr. Comrie on "Mathematical Gymnastics with Calculating Machines", and the other by Mr. Nilsson on "A Description of Calculating Machine Mechanisms".

M. E. P.

EVOLUTION IN SOCIETY

SIR WALTER LANGDON-BROWN, in his presidential address to the British Social Hygiene Council on October 12, discussed "The Place of Social Biology in the Sciences". He indicated that the interdependence of all life is shown by the fact that at every stage of the journey, from the apparently inert mineral to the conscious intelligent being, the 'laws' governing the lower levels apply to the higher, though the latter also develop new laws of their own. The most complex plant has to obey the ordinary laws of chemical combination as faithfully as has the soil from which it springs, but in addition it has acquired the capacity for building up food reserves by photosynthesis. Animals have acquired kinetic energy for which they are dependent on the potential energy of the plant, and they can effect, through catalysts, chemical reactions at ordinary temperatures which can only be imitated in the laboratory under conditions incompatible with life. The same holds for the progressive stages from simple reflex action through instinct to intelligence. At each step something fresh is added to the old law. Presumably this applies also to the still higher values of life. Yet though man lives by this balance of Nature, he is too apt to act like a bandit of the soil, converting fertile lands into deserts. The urgency of this matter is at once obscured but really intensified by urbanization.

Man is a gregarious animal and cannot live in isolation without dire injury to himself. Here biology and sociology are at one. Maudsley said "there could not be a greater danger to the balance of any mind than to be exempt from the bonds and pressure of the surrounding social system". Dictators illustrate that truth. Sir Arthur Keith has directed attention to two opposing tendencies in life—one the general demand of evolution for enlargement of the unit, the other the species-making impulse to segregate a particular type. The former makes for internationalism, the latter for nationalism. The present fanatical outbreak is the frightened and pathological response of the species-making impulse faced by the imperious demands of evolution. The nervous system was developed to allow of rapid co-operation between the various organs of the individual, and rapid communication is essential to the co-ordination of the complex civilization of to-day. The present issue is clear-cut: Do individuals exist for the State or the State for individuals? It is quite possible to win the war and yet to lose on that issue.

The human unit which must be conserved is the family. The child must be confident of security in one person and that person the mother. Mother love was the first moral value to emerge. Father love came later with the longer dependence of the young in the higher forms of life. Children of the same parents differ not only innately in their genes, but, as Adler pointed out, in their environment according to their position in the family, as can be seen by comparing the different reactions of the eldest, the second and the youngest. It is inevitable that for good or ill what the child makes of life will largely depend on the family life he has experienced. The serious misfits are usually the products of unhappy homes. To quote Prof. Wood-Jones, "if we realize that we . . . like all creatures have a part to play in a cosmic process greater than any individual, then we are likely to take a humbler and more balanced view of ourselves".

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, October 31

INSTITUTE OF PHYSICS (ELECTRONICS GROUP AND MIDLAND BRANCH) (at the College of Technology, Rugby), at 2.45 p.m.—Dr. D. Gabor: "Electron Optics".

ASSOCIATION OF SCIENTIFIC WORKERS (at the Royal Photographic Society, 16 Princes Gate, South Kensington, London, S.W.7), at 3 p.m.—Exhibition of "Photography in Science and Industry" (to be opened by Sir Robert Watson Watt, F.R.S.).

Tuesday, November 3

KODAK, LTD. (at Kodak House, Kingsway, London, W.C.2), at 2 p.m.—Exhibition of "Photography's Part in the War" (to be opened by the Rt. Hon. Lord Brabazon of Tara).*

SOCIETY OF CHEMICAL INDUSTRY (JOINT MEETING OF THE FOOD GROUP WITH THE AGRICULTURE GROUP) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Dr. G. H. Bates: "Increasing the Food Output of Great Britain".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Sir James Jeans, O.M., F.R.S.: "Evolution in Astronomy", 1.*

Wednesday, November 4

ASSOCIATION OF SCIENTIFIC WORKERS (at the Royal Photographic Society, 16 Princes Gate, South Kensington, London, S.W.7), at 6.30 p.m.—Dr. D. A. Spencer: "Photography as a Tool".

Thursday, November 5

TOWN AND COUNTRY PLANNING ASSOCIATION (in the Lounge of the Y.M.C.A., Central Buildings, Great Russell Street, London, W.C.1), at 1.15 p.m.—Mr. G. A. Jellicoe: "Landscape Architecture and Planning".

INSTITUTION OF ELECTRICAL ENGINEERS (JOINT MEETING WITH THE INSTITUTION OF MECHANICAL ENGINEERS) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. N. Waite: "Coal for Steam Raising".

Friday, November 6

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 4.30 p.m.—Prof. H. R. Robinson, F.R.S.: "Rutherford, Life and Work to the Year 1919, with Personal Reminiscences of the Manchester Period" (First Rutherford Memorial Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. W. V. Mayneord: "The Measurement of Radiation for Medical Purposes".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Lord Dudley G. Gordon: "Recent Developments in Refrigeration" (Thomas Hawksley Lecture).

ASSOCIATION OF SCIENTIFIC WORKERS (at the Royal Photographic Society, 16 Princes Gate, South Kensington, London, S.W.7), at 6.30 p.m.—Mr. E. D. Eyles: "Some Applications of High-Speed Photography".

Saturday, November 7

BIOCHEMICAL SOCIETY (in the Department of Organic Chemistry, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 11 a.m.: Discussion on "The Theory and Application of Chromatographic Methods to Biological Problems".

Saturday–Sunday, November 7–8

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at the Royal Society, Burlington House, Piccadilly, W.1).

Saturday

At 11 a.m.: Annual General Meeting. At 12 noon: Sir Richard Gregory, Bart., F.R.S.: "International Systems and Standards".

Sunday

At 10.30 a.m.: Symposium on Microfilm.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on o before the dates mentioned:

LECTURER IN MECHANICAL ENGINEERING with some knowledge o Electrical or Automobile Engineering—The Principal, College o Technology and Commerce, Leicester (November 7).

TEACHER OF MECHANICAL ENGINEERING—The Principal, Wolverto Technical College, Wolverton, Bucks. (November 7).

INSTRUCTOR IN ENGINEERING WORKSHOP PRACTICE at the Llanell Mining and Technical Institute—The Director of Education, Education Department, County Hall, The Castle, Carmarthen (November 7)

LECTURER IN MECHANICAL ENGINEERING at the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough (November 9).

HEAD OF THE MINING DEPARTMENT of the Chesterfield Technica College—The Clerk to the Governors, Technical College, Infirmar Road, Chesterfield (November 9).

A MACHINERY OFFICER, A DRAINAGE OFFICER, and AN ASSISTAN DRAINAGE OFFICER—The Executive Officer, Hampshire War Agr cultural Executive Committee, The Castle, Winchester (November 9

DEMONSTRATOR IN THE CHEMISTRY DEPARTMENT of the Londo (Royal Free Hospital) School of Medicine for Women (at the Unive sity College of the South West, Exeter)—The Warden and Secretar Reed Hall, Streatham Drive, Exeter (November 19).

LECTURER IN MATHEMATICS—The Principal, Stockport College fc Further Education, Stockport.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Scientific Journal of the Royal College of Science. Vol. 1 containing Papers read during the Session 1941–1942 before t Imperial College Chemical Society, the Royal College of Scien Mathematical and Physical Society, and contributions from the Roy College of Science Natural History Society. Pp. vi+158. (Londo Royal College of Science.) Paper, 4s.; cloth, 5s. 6d. [7

Medical Research Council. Special Report Series, No. 246: Repo of the Committee on Tuberculosis in War-Time. Pp. 36. (Londo H.M. Stationery Office.) 9d. net. [7

Other Countries

U.S. Department of Agriculture. Technical Bulletin No. 81 Soluble Materials of Soils in relation to their Classification and Gene Fertility. By M. S. Anderson, Mary G. Keyes and George W. Crom Pp. 79. (Washington, D.C.: Government Printing Office.) cents. [7

y College
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VENEREAL DISEASES: A SOCIOLOGICAL PROBLEM

THE Government is concerned about the present increase in venereal diseases throughout Great Britain. While the majority of us outside the medical profession, and quite a number of medical men themselves, treat the subject as we do, that is, taboo, the announcement that such an increase is taking place is no occasion for surprise; for, by implication alone, that is, without data, we are bound to conclude that with the present war-time change in conditions, accompanied by scarcely any change in the general attitude towards venereal disease as a social problem of the first magnitude, the whole problem is almost certain to loom up as a challenge to public health, leaving us concerned and confused.

Let us now look at the data as recently presented by Sir Wilson Jameson, chief medical officer of the Ministry of Health. Before the War, venereal disease in Great Britain was steadily decreasing; in fact, hitherto, compared with other countries, we had a very good record. In 1931, more than 9,000 cases of syphilis contracted during the year attended clinics in England and Wales. In 1939 this figure had fallen to about 5,000—a record reflecting credit on the medical research and services of the country. Last year, the number of new infections of syphilis among the civilian population treated at clinics (to which the great bulk of cases of syphilis go for treatment) was 7,332. The number of new cases of gonorrhœa is not known precisely because quite an appreciable number are treated by private medical practitioners, and venereal diseases are not notifiable. Roughly speaking, however, there are eight new infections of gonorrhœa to every one of syphilis. Therefore there was a total of nearly 70,000 new venereal infections among civilians last year. There were 5,000 cases of syphilis infection among civilians in 1939, 5,600 in 1940 and 7,300 in 1941. If to this be added the infections in the Services, there has been an increase of about 70 per cent infections in Great Britain since the War began. This need not necessarily give cause for alarm, because a certain increase is inevitable in present conditions. But it does present food for thought. Are we as a community approaching the problem at the right angle? Is not the long-distance view the better one to take in this case?

It is a matter for reflection that many men of science might immediately respond: 'What has this to do with us? It is the concern of our medical colleagues.' On closer consideration, however, we must admit that it is not only a matter for the concern of men of science, especially biologists and educationists, but also it is all the more serious because so many men of science are ignoring this fact. The whole problem is a sociological one of the first magnitude, and might well become more serious unless more public-spirited people help to grapple with it. It is useless to adopt, as we have tended to do in the past, a policy of *laisser-faire*, and it is certainly neither fair nor wise to leave it to the Government, for many members of this or any other Government of the past probably need as much enlightenment as the rest of us. It is undoubtedly a problem for Government, local authorities, Church, medical men, men of science, educationists and others, all working together in enlightened harmony.

Here we are concerned only with men of science—especially biologists and educationists. What have they done and what are they doing to meet a situation which has really been facing us for years, though now in a more acute form, as is usual in war-time ? Medicine offers much, and, in fact, is probably doing as much as can be expected of it. Sir Wilson Jameson has revealed that in England and Wales there are two hundred treatment centres, mostly at hospitals, with skilled staffs and equipment. More treatment facilities have been set up to meet war-time contingencies. If everyone who contracts one of these venereal diseases would only seek skilled treatment at the earliest possible stage, and continue it, *the problem would be reduced to manageable proportions within a few months.*

Can we ask much more than this of the medical men ? Being the men on the job, they must inevitably realize the seriousness of the problem. This has been so since long before the War. But even the medical men have been too prone to look upon the problem rather as an exclusively medical, or we might say, technical one. Now they are beginning to realize that the whole question must be considered from more angles than that of physic or public health. The Central Council for Health Education*, which is composed almost entirely of public-spirited medical men, under the chairmanship of Dr. C. Hill, the capable and energetic deputy secretary of the British Medical Association, and inspired by the presidency of no less a social leader than the Archbishop of Canterbury, is attacking the whole issue as a sociological problem of the utmost importance. Lectures throughout the country by an authoritative and well-trained staff, films and pamphlets on health subjects (paying special attention to venereal disease) all come within the ambit of the Central Council, which works in close liaison with the Ministry of Health. Thus are medical men courageously tackling, in a manner which brooks little criticism, a problem which otherwise might well seriously undermine the physical, mental and moral health of the country.

But this War, like the last though even more so, has brought into the limelight a serious sociological defect that has really been evident to those who would see for a very long time. We, as men of science, may leave it to the Ministry of Health, the Central Council for Health Education, and other authorities to deal with the exceptional and very difficult health problems which have become intensified in a country at war. But what of the future ? Is it fair to leave it all to the medical profession ? And do the majority of medical men themselves realize what is the fundamental root of the entire problem ? Are medical men and their organizations responsible for the deplorable state of the country (and indeed the whole world) so far as venereal disease is concerned ? If we refer back to the claim that the whole problem "would be reduced to manageable proportions within a few months", we must give a negative reply to all these questions.

It is the opinion of the Ministry of Health that the first requirement in combating the spread of venereal disease is 'open discussion'. This seems very reasonable, for here we have local authorities and their medical organizations, institutes, advisers and practitioners, offering free and confidential treatment, yet the whole of this valuable social service is handicapped by what Sir Wilson Jameson calls "this misguided secrecy". "Because of an old tradition of 'hush-hush' on the matter, the public does not know what it ought to know." It is not a question of the knowledge at the disposal of the medical profession, but more a problem of the application to society of already well-known discoveries. There is no need to make any startlingly new medical discoveries ; *we have the information needed to deal with venereal diseases.*

Clearly there is something very wrong with a community which is suffering from a blot on its public health system, has the wherewithal for erasing it, yet fails to do so. Educationists and men of science—especially biologists—must be aware of the difficulties of their medical colleagues ; they must therefore show their awareness and come forward and do their share more openly. The public must be informed, of course ; but there lies the difficulty. The 'hush-hush' tradition is an intolerable handicap ; this "misguided secrecy" is a ludicrous, almost Gilbertian, blockade to progress. A medical practitioner can discuss the most intimate details of a case of pregnancy with a woman and still remain a gentleman ; why cannot he be given the same chance in this connexion ?

Much is due to *laisser-faire*, much to the ignorance of those who in any event never appeal to medicine or science until something goes wrong—and sometimes not even then ; but one major cause of the difficulty can be ascribed to those present-day people who resent open discussion (consequently public enlightenment) of a quite understandable problem. Venereal disease can scarcely be claimed to be a topic for the drawing-room, but then neither are cancer, tuberculosis, or even nutrition, except perhaps war-time food rationing. Therefore, whether those members of the community who pursue the policy of the ostrich or the hypocrite are to be appeased or ignored is a matter for the State authorities. As Sir Wilson Jameson has said, we shall never combat and eventually bring this scourge under control by running away from it, by shutting our eyes to its existence, by refusing to discuss it, or by withholding from young people information regarding its dangers. We have the knowledge and the facilities we need. Early diagnosis and early skilled treatment are available, and everyone should be made aware of the prevalence of venereal disease, how it is contracted and how it can be cured. There must be no more secrecy.

The fact that the State is in this quandary is one of general, and therefore much wider, responsibility. It is surely a matter of education—general education. If the ordinary man had developed, through the formal education of his earlier years, the correct frame of mind and a rational attitude towards life, it would be possible to discuss with him the seriousness of venereal disease as easily and frankly as it is to warn him against sneezing in public. To over-ride all this should be the ultimate, and therefore fundamentally the most important aim, in the whole problem; the immediate aim—curing of those afflicted—is the concern of medical men. If the educationist gave his charges the best and most liberal education, he would hand over to society broad-minded, rational citizens who would give no special concern to health authorities so far as venereal or indeed other diseases are concerned. This is not to suggest that the subject of venereal disease should ever be discussed or even mentioned in our schools; it would be a sad day if and when this ever became necessary.

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* Tavistock House, Tavistock Square, London, W.C.1.

Most medical men and many other biologists can discuss with their colleagues the problems involved in connexion with venereal disease without turning a hair, but they could not do so without an acute feeling of embarrassment with non-biologists, nor indeed with many who have had a certain amount of biological training. Here, therefore, lies a strong argument in favour of every child being given a broad biological background during his school years, and this should begin long before he personally attains physical sexual maturity. During any complete survey of the field of biology in our schools, the elements of human reproduction should receive consideration in their logical place in the scheme of the curriculum. Human reproduction should not be left, as it so often is, to implication from the study of reproduction in the rabbit or the frog. By this, we do not for one moment suggest that sex should be emphasized in any way, and certainly venereal disease should never be considered, any more than a teacher would discuss in school the details of an operation for appendicitis. The general concepts of healthy living would, however, inevitably find a place in the curriculum. If a man or woman had been correctly trained in the elements of general biology, then discussion of venereal disease in later life (if it arose out of necessity as it has now) would not give cause for embarrassment, and it surely would never have to take place, metaphorically speaking, behind closed doors, though, for many obvious reasons, a certain amount of secrecy in each individual case is desirable.

Many of our medical men realize all this. For the first time, on October 23, Sir Wilson Jameson broadcast a thoughtful and well-balanced talk through the B.B.C. to the British public on the questions of tuberculosis and venereal disease. So also is the Central Council for Health Education acting vigorously. This Council is taking both the immediate and long-distance view. For the latter reason, the Council has established an Educational Advisory Committee. Let it be said at once that this Committee is not concerned especially with the problems of venereal disease. It is composed of well-known educationists and representatives of educational organizations, biologists and medical men; and its main function is to advise the Central Council on questions of general biological teaching, but with special reference to healthy living. Sex, and certainly venereal disease, are never specially picked out during its deliberations; in fact, there is not one specialist in venereology among its medical members. Its function is, through the machinery of the parent body, to assist, advise and criticize wherever necessary, so that there may eventually be established throughout Great Britain a better and more balanced training in biological principles, chiefly in the schools. Though the Committee is in no way influenced by the Board of Education, the Board is represented at it. The Ministries of Health and Food also send observers. The Committee feels that through its efforts, with others, in the years to come our citizens will attain a sense of real values and will better be able to face squarely and fearlessly any problems of public health, well-being and progress which may arise.

The present rise in incidence of venereal disease is, as in the past, mainly the result of the absence in our men and women of a biological attitude towards, and an informed view of, life. It is partially the results of faulty training in the schools. The same can be said of nutrition and other aspects of human biology. It is impossible to teach and guide the public completely and satisfactorily because of this ill-informed attitude of the public itself. If our men and women were more cognizant of the facts of the human body and human relations, they would develop a more positive attitude towards human ailments and frailties, and the negative influence of other drawbacks in our society would then largely be eliminated. If our citizens of to-morrow are given a broad outlook in biology, then many of our sociological defects, such as venereal disease, the pernicious influence of quack medicines, malnutrition, the lack of physical training, and so forth, will either disappear entirely or at any rate will not be aggravated by the evil influence of 'hush-hush', or allowed to exist because of igrorance on the part of the general public; further, they will be brought into a sane field of vision and action.

As things are, one Government after another finds itself faced with the need for legislation and organization of many factors concerning public well-being which should never arise. As Sir John Orr, one of the members of the Educational Advisory Committee, claims, malnutrition is one of the major issues of national and international policy and will become even more so. The same may be said of other aspects of public health. Once educationists in general, and biologists in particular, have got down to their duties more in keeping with up-to-date principles of education, then we shall be well on the road towards that desirable goal where we can naturally and sanely consider *all* problems of human biology and sociology in open discussion, and thus set in motion the machinery for combating the enemies of individual and public health and social progress—machinery meticulously constructed by medical, scientific and educational research and oiled by public sympathy, goodwill and confidence.

THE MANUSCRIPTS OF C. W. SCHEELE

Carl Wilhelm Scheele

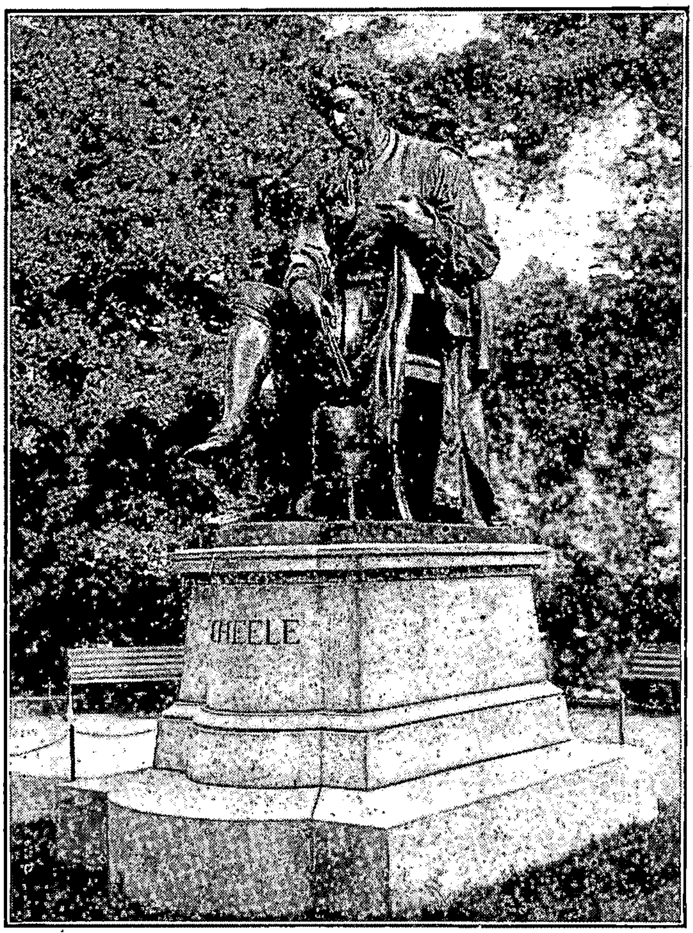
Manuskript 1756–1777. Tolkning av C. W. Oseen. Pp. vi+173. Manuskript 1756–1777. Ordnade av C. W. Oseen. Ljustryck. Pp. v+182. (Stockholm: K. Svenska Vetenskapsakademien, 1942.)

JUST as Edmund Spenser is called 'the poet's poet', so Carl Wilhelm Scheele merits the title of 'the chemist's chemist'. Lacking all formal training in science, he was instinctively the perfect investigator. In experimental technique, Campbell Brown has remarked in his "History of Chemistry", Scheele has never been surpassed. "His discoveries were the result of carefully planned series of experiments, and he left nothing in doubt where experiment could decide it. He is a model to all who are engaged in chemical research."

Born in 1742 at Stralsund, the chief town of what was at that date Swedish Pomerania, Scheele was apprenticed to an apothecary in Gothenburg at the age of fourteen and spent practically the rest of his all-too-short career—he died at Köping in 1786—as a pharmacist in Sweden. Struggling always against poverty and ill-health, he planned and performed his chemical experiments day after day and year after year in the isolation of provincial shop-laboratories, knowing little (except through correspondence) about the work of his contemporaries in other countries and remaining himself almost completely unrecognized until 1777, when he published his "Chemical Treatise on Air and Fire". He literally lived for his research work, as may be seen by an extract from a letter which he wrote to his friend Gahn in 1775:

"Oh, how happy I am! No care for eating or drinking or dwelling, no care for my pharmaceutical business, for that is mere play to me. But to watch new phenomena—this is all my desire, and how glad is the enquirer when discovery rewards his diligence; then his heart rejoices."

Among the numerous discoveries which rewarded Scheele's diligence and made his heart rejoice were two of really primary importance—oxygen and chlorine. Priestley, it is true, was the first to announce the discovery of oxygen, and he is commonly given the principal credit therefor, but we know now from Scheele's note-books that he had prepared the element systematically in several different ways prior to the more famous, but comparatively casual, experiments of Priestley in 1774. After Scheele's death, the Royal Swedish Academy of Sciences commissioned its secretary, J. C. Wilcke, to deliver a memorial address, and the manuscripts which Wilcke obtained from Scheele's widow to assist him in the preparation of this address were afterwards deposited in the archives of the Academy. Fifty years ago, certain of these manuscripts were published in a stately volume by A. E. Nordenskiöld: "Carl Wilhelm Scheele. Correspondence and Laboratory Notes" (Stockholm, 1892). As Dr. Leonard Dobbin, in his valuable book, "The Collected Papers of Carl Wilhelm Scheele" (Bell and Sons, 1931), has stated, the introduction to this volume, together with Nordenskiöld's annotations and additional matter, provides a wealth of interesting biographical and other information, much of which is not included in earlier biographies. Nordenskiöld concludes his own biographical sketch with the following paragraph: "The picture which biographers have given of Scheele as an investigator is incomplete. It is only by the aid of the letters and laboratory records here presented that we can obtain a grasp of the insatiable thirst for knowledge which impelled him to separate and to examine in his flasks, retorts and crucibles everything that came into his hands; of the number and importance of his chemical discoveries; of the range of the experiments upon which every communication that appeared in print was based; of the discernment with which even the most inconspicuous phenomena were observed and utilized as guides in the elucidation of new truths; and of Scheele's true significance as a real pioneer of scientific chemistry."



CARL WILHELM SCHEELE

The statue stands in Humlegården, one of Stockholm's many beautiful parks. It was modelled by J. Börjeson and unveiled in 1892, in commemoration of the sesquicentenary of Scheele's birth.

It now appears, however, that Nordenskiöld's picture is itself extremely incomplete. Fru Elin Bergsten, who was entrusted with the task of deciphering the manuscripts, was a skilful palæographer but no chemist, and had perforce to leave no small portion of their contents unexplained. It is to fill up the extensive gaps in Fru Bergsten's transcriptions that the two volumes here under review are devoted.

The immediate urge for their publication is twofold. First of all, there is the desire of the Royal Swedish Academy of Sciences to celebrate in appropriate manner the bicentenary of Scheele's birth in 1742 (the exact date is December 19). The second factor can best be explained by direct translation from Prof. C. W. Oseen's preface:

"Modern methods of waging war threaten all memorials of civilization with annihilation. No other salvation from this danger is offered to the strongest of such memorials, old buildings, than chance may bring. There is, however, one method of saving the weakest and the most easily destroyed, —the written page: not quite certain, but almost certain. Reproduction of a sufficient number of copies and dissemination of these copies in a sufficient number of different places ensures, with practical certainty, that some one of the copies will escape destruction.

"Have these manuscripts of Carl Wilhelm Scheele such value for the present and future generations that their preservation in a world of destruction can be justified? The answer is that if these manuscripts can only be correctly dated, then we shall be able to fix the dates of Scheele's discoveries. An attempt in this direction was made by A. E. Nordenskiöld about 1890, but such a task is too much for one man; it demands the collaboration of all those scientific men who are interested in the subject. To render such collaboration possible is one of the objects of this publication of Scheele's manuscripts.

"Is it, now, so important to know, *when* Scheele made his discoveries? This publication is based on the assumption that it is important, both for us and for those who will come after us, to know the past, in other words on the assumption that civilisation will persist and not be destroyed."

Therefore Sweden, fortunate enough so far to have escaped the 'crocodile', safeguards the human race against the still imminent wanton destruction of her scientific treasures by presenting these priceless manuscripts to the world at large "in the war-year of 1942". It is a noble project, and it has been nobly accomplished. One of the two volumes comprises 182 pages of beautiful photographic reproductions of the manuscripts themselves, arranged by Prof. Oseen. In the other volume, Prof. Oseen has "decoded" Scheele's crabbed conglomerations of alchemical and pharmaceutical signs, dog-Latin and contracted German, into modern print. How onerous the task was, and how conscientiously and skilfully it has been carried to completion, can be fully appreciated only by careful comparison of corresponding sections.

In thirteen pages of notes at the end of the second volume, Prof. Oseen discusses in a scholarly manner certain of the chronological problems involved, particularly with respect to two of the most important oxygen manuscripts, No. 43 and No. 52. His conclusions regarding the latter differ significantly from those of Nordenskiöld, and the arguments presented are of considerable interest in indicating the general line of attack which must be followed in order to arrive at the final goal—the authoritative dating of all Scheele's manuscripts. This pleasant duty will undoubtedly attract the keenest collaboration of chemical historians in all countries in the more tranquil future.

JAMES KENDALL.

PHOTOGRAPHIC IDENTIFICATION OF TIMBERS

Studies of the Identification of Timbers

With a Note on the Seasoning of Wood. By Alexander L. Howard. Pp. v+110. (London: Macmillan and Co., Ltd., 1942.) 36*s*. net.

MR. ALEXANDER L. HOWARD'S well-known and much-used book entitled "A Manual of the Timbers of the World", of which the last edition was published in 1934, contains no illustrations of the structure of wood. In order to remedy this defect, and to facilitate the identification of timbers, he has now published a new companion volume, of which the principal contents consist of 504 photographs of transverse sections of different kinds of wood magnified by ten. Each illustration is about 3 cm. × 5·5 cm. and therefore represents an actual cross-sectional area of just over 1½ sq. cm. of wood. All these illustrations were prepared by Mr. G. R. Keen from microtome sections which he himself cut from Mr. Howard's own collection of authentic specimens. The work entailed must have been very considerable, and to have produced a book of this kind after three years of war shows no small enterprise on the part of all concerned.

One must confess, however, that the result is somewhat disappointing. In the first place the illustrations are of very variable quality; while some of them are reasonably satisfactory, others fail to give a fair representation of the timber concerned. This applies especially to Nos. 42, 57, 67, 113, 121, 136, 278, 359, and 370, to mention a few of the less inspiring. Illustrations more like those in H. P. Brown's "Atlas of Commercial Timbers of the United States" or Pearson and Brown's "Commercial Timbers of India" would have been far more useful. As, moreover, timber merchants generally have to examine a transverse surface of a solid piece of wood cut with a sharp knife, rather than sections, it would have been far better to photograph the actual surface of the wood. Only a highly skilled photographer could secure the best possible results by this method, but the work entailed would have been well worth while. It is a great pity that Mr. Howard went to the trouble of preparing a special set of sections when comprehensive collections of microscopical slides already exist at several institutions where the identification of timbers and the preparation of photomicrographs are matters of routine. By collaborating with one or more of these institutions a better result could have been achieved.

It is, besides, impossible to portray all the possible variations in wood structure which occur within a single botanical species in a solitary photograph of a cross-sectional area of just over 1½ sq. cm. This is one of the reasons why the book does not always enable the user to identify the woods with certainty. If verbal descriptions as well as the illustrations had been included, some idea of the variations which are to be expected in a single kind of wood could have been given. Another difficulty is that many timbers, especially among the softwoods, can be identified with certainty only by characters visible with a compound microscope. By relying on lens characters alone and comparing them with the illustrations in this book, it would, for example, be quite easy to confuse the timbers shown in Figs. 241, 314 and 453 respectively. The botanist and forester will also object to the curious alphabetical sequence in which the timbers are arranged; vernacular, trade and botanical names having been used quite indiscriminately. The separate indexes of botanical and other names at the end of the book help to overcome this defect. In many instances the botanical names are not recorded at all, which is to be deplored in a work of reference. This curious arrangement is similar to that previously adopted in "A Manual of the Timbers of the World".

It is rather surprising in a book on timber identification to find that the only text, apart from the preface, consists of some forty pages describing the conversion and seasoning of timber. This, however, provides a useful and authoritative summary.

Taken as a whole, the book will be found helpful in identifying timbers, especially by those who are casually interested or to whom a collection of authentic specimens is not easily accessible. It also enables a rapid preliminary comparison to be made whenever a specimen is received for identification. It will, however, be desirable to consult other sources of information when precise and accurate identifications are required; for example, when settling legal disputes.

If Mr. Howard had taken some of his many scientific friends more fully into his confidence before publishing this book, a notable addition to our applied botanical literature might have been achieved. A book based on his long practical knowledge of the trade, combined with that of an experienced botanist or forester, would have been well worth while.

C. R. METCALFE.

HYDROGEN IONS IN PURE AND INDUSTRIAL CHEMISTRY

Hydrogen Ions

Their Determination and Importance in Pure and Industrial Chemistry. By Prof. Hubert T. S. Britton. (Monographs on Applied Chemistry, Vol. 3.) Third edition, thoroughly revised and enlarged. Vol. 1. Pp. xix+420. 36*s.* net. Vol. 2. Pp. xix+443. 36*s.* net. (London: Chapman and Hall, Ltd., 1942.)

THE appearance of a third edition of Prof. Britton's well-known text-book on "Hydrogen Ions" will be welcomed by those physical chemists who are concerned with the control of analytical and industrial processes by means of *p*H measurements. The ten years which have elapsed since the publication of the second edition have seen a large increase in the original literature of the subject and this has necessitated a considerable increase (some 274 pages) in the size of the book and its division into two volumes. The book is well printed on good paper and shows few signs of war-time austerity, with the exception of the price, which has increased nearly 200 per cent: perhaps this is only the shape of things to come.

The importance of *p*H measurements in analytical operations, electro-deposition and tanning processes, in the sugar, paper, brewing, dairy and explosive industries, in baking, water purification and sewage disposal, in agriculture and the textile and dyeing industries, in ore flotation, etc., fully justifies the appearance of this new edition, for it is a valuable contribution to our technical sinews of war. The book is a mine of information particularly concerning the practical aspects of *p*H measurement, and the author draws freely on his extensive practical experience in his critical assessment of the experimental methods described. The numerous tables of information and practical notes make the book a valuable *vade mecum* for all concerned with *p*H measurement.

Besides the more technical aspects of hydrogen ion measurements, the author discusses subjects of more academic interest; for example, the ionization of dibasic and poly-basic acids, the Lowry–Brønsted theory of acids and bases, etc. The new edition also includes a chapter on oxidation-reduction processes, including the use of redox indicators.

The book has been written primarily for those concerned with the industrial aspects of physical chemistry. Those concerned with the more theoretical aspects of the electrochemistry of solutions will find in the book much to interest and instruct them, but some will perhaps be a little dissatisfied with the treatment of the more modern aspects of the subject. At what stage in his course should a student be introduced to the newer theories of electrolytic dissociation? This question, no doubt, exercises the minds of many teachers. Prof. Britton has adopted in his book, what is the common practice, of first tentatively applying the Arrhenius theory to strong electrolytes and only at a much later stage, half-way through the first volume, introducing the activity concept. This procedure is not altogether satisfactory as it necessitates frequent qualification of statements in the earlier part of the book, a procedure which must cause confusion to a reader not already familiar with the subject.

So much has already been written of *p*H and buffer solutions which is based on the erroneous assumption of Arrhenius concerning the dissociation of strong electrolytes that considerable confusion would be caused by changing to the more satisfactory thermodynamic basis. The standard of reference of any potentiometric scale is an arbitrary one, so why change it, even if the older definition of the standard hydrogen electrode is not satisfactory? The author gives these reasons (pp. 292–294) for his retention of the original definition of *p*H, and many would agree on grounds of expediency. The criticism of the modern theory given as an additional reason for retention of the older concepts will not meet with such wide agreement, for the statement concerning the impossibility of determining single ion activity coefficients is perhaps a little unfair; a very similar criticism can be made against the concept of the single electrode potential used by the author.

The chapter on the Debye-Hückel theory has been largely re-written, but room has not been found to include an account of the success which has attended the application and extension of these ideas to the interpretation of the electrical conductivity of strong electrolytes and the effect of high potentials and high frequencies on the conductivity. No mention is made of the interesting work of Wien and of Onsager on the effect of high potentials on the dissociation of weak acids, nor is the heavy hydrogen ion discussed. Reasons of space, no doubt, made it necessary for the author to circumscribe his field.

Another edition of this book will certainly be called for in the not too distant future, and it will no doubt be necessary for Prof. Britton to put the chemical community more in his debt by enlarging his book still further.

H. L. RILEY.

DARWIN MANUSCRIPTS AND LETTERS

GIFTS TO CAMBRIDGE AND TO DOWN HOUSE

A GENEROUS and timely grant from the Pilgrim Trust has enabled the owners of certain important manuscripts of Charles Darwin to present them, some to the University Library at Cambridge and some to the British Association for preservation at Down House. The gift includes the manuscript of Charles Darwin's autobiography, the manuscript of the diary of the *Beagle*, with the field note-books from which it was compiled, most of the manuscript of the "Origin of Species", the manuscript of "Movement in Plants", "Climbing Plants", and other works ; correspondence with Wallace, Samuel Butler, Huxley and other contemporaries ; a number of personal papers and of memoranda relating to Down ; and a collection of pamphlets, some with his annotations. It was in 1842 that Charles Darwin went to live at Down House. The first sketch, in his handwriting, of his species theory, written in 1842, is included in the gift.

A wise division of these manuscripts has been made. To the Library at Cambridge go the papers which, as will be seen, possess the highest possible value to the history of scientific research—papers which generations of future students may well wish to reinvestigate. To Down House, Darwin's home from 1842 until his death in 1882, now held by the British Association as a national memorial under the gift of Sir Buckston Browne, there return those priceless relics which will be most appropriate for those who visit the place to see—"exhibitable objects", as they were termed by one of those responsible for the division. Down House is closed to the public now, but when it becomes possible to reopen it, the collection of Darwiniana, viewed before the War by some seven thousand visitors annually, will be found to be enhanced by additions of unique personal interest.

A few examples only can be chosen for mention here out of the large mass of material comprised in the gifts. Among the documents destined for Cambridge are, foremost, sketches of "The Origin of Species", dating from 1842 and 1844, and manuscripts of chapters of the work as originally planned, and before the work was abstracted for publication in 1859. There is a fair copy of a draft, annotated by Darwin and Hooker, on "Varieties in Large Genera". There are manuscripts, complete or partial, of, or relating to, the "Expression of the Emotions", "The Movements and Habits of Climbing Plants", the "Cross- and Self-fertilization of Plants", "The Power of Movement in Plants", and other works. There are also manuscripts of a number of short papers communicated to scientific societies and periodicals.

Numerous scientific notes, in books or on loose sheets, are included in the collection. Some are very early, dating from Darwin's short period at the University of Edinburgh as well as from his Cambridge days. Among the material of later date is much that relates not only to the major works but also to other investigations—the names of the parallel roads of Glenroy and of Salisbury Craigs appear ; glacial studies, coral reefs, Peloria, phyllotaxy, pangenesis, embryology, hybridism, are a few among many subjects. Memoranda for later editions of "The Origin of Species", "The Descent of Man", "Coral Reefs", "Climbing Plants", "Orchids", "Cross- and Self-fertilization" are included.

In this group of documents there are also the small brass-clasped notebooks kept during the voyage of the *Beagle* and the classified scientific notes made up from these : it is to be noticed that as each page in the notebooks was collated it was crossed through. The very records of observations and incidents made during that arduous voyage, often, it must have been, in circumstances of difficulty and stress, cannot be viewed without reverence ; and they will be available to the view of those who visit Down in future, for they go back there, together with the manuscript of the "Diary", which, as is well known, was published verbatim not many years ago under the care of Lady Barlow. The classified scientific notes, however, are rightly included in the Cambridge collection.

Letters are many. These have, of course, been exhaustively worked upon during the compilation of the "Life and Letters of Charles Darwin" and of "More Letters of Charles Darwin" ; nevertheless, they again are more appropriate to a library than to exhibition, and the majority go to Cambridge, though those written from the *Beagle* are retained for Down House with the notebooks. It has been noticed that such few letters as in normal times are open to view (in stands) in the Down House collection are assiduously read by many visitors ; but correspondence could never be exhibited in bulk.

There are a few scientific notes relating to Down and its neighbourhood, and these now return to their source. There is, for example, a list of plants, grasses, etc., on the lawn at Down, in 1856–58 : it might be a labour of love for a botanist to determine which of these, and how many more, appear there now. Among other local observations, there are the notes which were kept by Horace Darwin, from 1878 onward, in continuation of his father's study of the work of earthworms. Rainfall records are associated with the dampness and dryness of the soil, and these with measurements of the movement of the heavy stone (still in its place) which has become known as the wormstone : the term 'wormograph', which heads the notes, was mercifully relinquished.

Apart from the material already mentioned, the bulk of the gift to the British Association is not of a scientific character, but intimate and personal to Darwin, as befits a gift to the present guardians of his home. His own diary of his health, from 1849 to 1854, survives. A number of private account-books have been preserved. It is on record that Darwin rated his own business ability highly (if that phrase be not inapplicable to a man so innately modest) ; the account-books bear out this estimate. Personal expenditure is meticulously classified under various general headings—his partiality for snuff, by the way, is exhibited under the heading of "Amusements", and that of Mrs. Darwin for the theatre is apparent before they left London to live at Down. No less apparent is their generosity to dependants and others. Much may be inferred from these accounts concerning the regime at Down : the items of expenditure on the estate are not without value for the guidance of those who now are charged with its maintenance ; and the entries, in earlier days, concerning livestock and so forth do something to justify the surprising reference which occurs in Bagshaw's Directory of 1847—"Darwin, Charles, farmer".

EFFECTS OF CLOTHING AND FUEL SHORTAGE ON HEALTH*

By Sir Leonard Hill, F.R.S.

HAIR, feathers, fur and clothes protect the body from loss of heat, not by the quality of solid substance but by the air entangled in the meshes of these. Air is a bad heat conductor; warmed up to skin temperature and kept stationary, it acts as an insulator, preventing heat loss.

If the thermal conductivity of air be taken as unity that of wool fibre is 6, of water at least 240. The heat capacity of water is more than 3,000 times that of air, hence the great cooling power of cold water. A given volume of fur consists of about 2 per cent solid and 98 per cent air. A rabbit with skin shaved and varnished had its heat loss increased by nearly 1½ times in a room at ordinary temperature.

Darwin described natives of Tierra del Fuego—the woman with babe at her breast, naked in the falling sleet, the man with an otter-skin the size of a handkerchief, which he shifted to the side struck by the wind. Sleeping on the ground like hares these natives had to commit infanticide, so hardy were they, to keep the population down to the food supply. Native Australians kept dogs to warm themselves at night, stripping bark off a tree to protect their naked bodies from wind. Eskimo dressed in furs withstand howling blizzards and temperatures as low as 70° F. of frost, and will crouch with their spears over the holes patiently waiting for seals to come up to breathe, and so stay even for three days. In their igloos, built of snow blocks over ice, which is much warmer than frozen land, they use blubber-lamps, and are so warm with these and their own body heat, that they discard all clothing while inside. Roman Catholic priests, born in Paris, have acclimatized themselves to live as Eskimos protected by fur garments. One such priest lived in a hole in the ground, far colder than an igloo. The northern Chinese, who endure five months of rigorously cold weather, use little fuel, but attain comparative comfort by wearing a wadded gown with long sleeves, and wadded trousers bound round the ankle. Cotton waste is used as wadding. Contrast these garments with the thin underclothing, short skirts, silk stockings and thin shoes of our womenfolk. Here is the way to save fuel—if people wear suitable clothing, houses and factories need be far less heated. The Chinese do not have an open fireplace with most of the heat going up the chimney, but a stove, with a long metal pipe as flue, which, while traversing the room, gives up its heat.

To save fuel women's thin and flimsy garments can be amplified by overalls, trousers and tunics, with such undergarments as are available. Shawls, overcoats and mackintoshes can be worn indoors for sedentary occupations, and their protective effect can be amplified, if needed, by a hot bottle to the feet and a rug over the knees. People can thus keep warm without artificial heat, as they do in the back seat of a motor-car. The factories would then have to be artificially heated only just enough to keep the hands warm for skilled work.

For sedentary occupations an ordinary citizen secures an atmosphere under his clothes of about 91° F.; only about one fifth of his skin surface is exposed to the air. Naked he finds a room at 80° F. pleasant, one at 60° F. cold. Those who habitually go with little clothing and are most exposed to the open air show the greatest immunity to what are termed 'colds'—respiratory affections which are really caused by infection in stuffy, artificially heated rooms. Leaving aside the question of fuel-saving, modern girls in their scant attire get the advantage of sun and air, as does the boy scout with shorts, bare knees and a shirt open at the neck. Babies, for fear of cold, are often overclad, and head sweating and evaporation from the lungs are then sometimes the only means left for getting rid of body heat. The children in an open-air sanatorium, clad in one garment, sit up in bed and play, indifferent to open windows. Out of doors they enjoy exposure nude to sun and air, but the exposure must not be overdone. The children must be able to assimulate enough well-chosen food to produce the body heat production required.

Exposure to cold makes the lamp of life burn brightly. A baby is born with great powers to withstand changes of climatic environment. Well fed, and given some exposure to open air and sun, naked when the weather is good, allowed plenty of kicking and crawling, with no prolonged confinement when awake in cradle and perambulator, with long sleeps out of doors, and light clothing, babies grow up virile with strong muscles and firm bones. While in winter a man may carry a tenth of his weight in his clothes, a dog carries only 2 per cent of its weight in its fur. A woman in modern dress carries less than half as much as a man, but have in consequence suffered no more from 'colds', pneumonia or rheumatism, and their death-rate has not been put up. The secondary schools have turned out fine, healthy and athletic girls and the women have worked wonders in the munitions factories.

Clothing should not be so heavy as to interfere with the taking of vigorous exercise. The athlete wears scanty clothing because his efforts may increase his heat production by five times or more.

It is a mistake except in very cold weather to put on an overcoat when going out to walk. The overcoat is useful when sitting indoors so as to allow a window open on a cool day. It is only the old, the underfed and ill and feeble who require very warm clothing. It should be kept in mind that those who are paralysed, anæsthetized or in a state of shock have lost their power of heat regulation and may easily be over-heated by hot bottles and too much clothing. The difference between the winter and summer pelts of the horse and cow show the small amount of extra clothing needed to face the open air in winter. Thick woollens and furs are needed not by citizens but by arctic travellers, airmen and soldiers in freezing trenches.

Clothes require to be made so as to be easily adjusted to changes of climate, in place of being fashioned to satisfy vanity. They should be as light as possible, allow free evaporation, become to the least degree wet with sweat and not cling to the skin when wet. The cellular structure produced by weaving, whether of wool, cotton, linen or silk, secures conditions which by entanglement of air gives warmth, pliability and evaporative power. Smooth, closely woven and glazed materials, as in a mackintosh or oilskin, give protection from wind and water. Wool has an elastic fibre which when worn keeps the garment off the skin, and prevents it clinging when wet. A fine woven linen or cotton is cooler than flannel because less air is entangled within the meshes. Made equally cellular in structure, linen or cotton garments are as warm as flannel, but they cling when wet.

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* Substance of a Chadwick Public Lecture delivered on October 6.

The question of wetting and clinging and of wearing and washing properties have to be taken into account. By taking off an outer garment, and by free ventilation, work can be carried out in factories in warm weather and without excessive call on the workers' sweat mechanism, which is the emergency method of keeping cool.

Fashion and custom should not prevent people taking off outer garments when feeling too warm. Employees should then be encouraged to work in their shirt sleeves, or bare to the waist. Heat loss from the body is then made easier by ventilation and free evaporation of sweat and by radiation of the skin to cooler surroundings. The evolution of the warm-blooded animal took place when animals warmed up by the sun succeeded by greater activity so induced, and came to evolve mechanisms for lessening heat loss in the shade by increasing heat production. Tropical lizards expand their pigment cells in their skin, and, absorbing sun rays, are warmed up to about 100° F. and then become very active. By open mouth and rapid breathing they evaporate enough water to prevent over-heating. At night they become cold and inert. Such lizards warmed by hot water pipes at the Zoo died in the winter. Given radiant heat on my suggestion, they eat and thrive. At body temperature black skin emits radiant heat rays just as much as white skin, but white skin reflects sun rays about double as much as black, which also absorbs much more. In the black and white furred animals exposed to the sun the black patches are much warmer than the white; so too, in the sun the dark hair of the scalp is much warmer than the white skin, but custom prevents consciousness of this difference. The sun's rays absorbed by the pigment of the skin increase transpiration from the capillaries and excite sweating and so cooling by evaporation. The black skin of a Negro when glistening with sweat reflects sun rays. Owing to protective pigment his skin can be thin and he blood vessels near to the surface; so the Negro loses heat easily from shaded parts of his body. The horny layer of the skin absorbs the short, active ultra-violet rays, and its thickening through exposure o these protects from sunburn. The pigment produced in the white skin by exposure to the sun protects the deeper parts of the skin from overheating.

Convention keeps children clothed in the tropics when they should wear only a loin-cloth, tan in the sun, be in and out of water and live open-air lives. Indoor conditions in the tropics make white women fade and age quickly. The white man can acclimatize himself to work in tropical heat when not overclothed and overfed. The conditions which favour heat-stroke are tight clothing and hot ground, high ir humidity, little wind and crowding. The limits of heat regulation in still air are wet bulb temperatures of 0° F. and 93° F. in air moving at two miles an hour; but work is then very inefficient. It is then most mportant to secure proper cooling of the body for workers by suitable clothing and ventilation. The heat loss from the body of a man engaged in ordinary physical work is required to be about three times that at rest, to counteract the greater body heat roduction.

The absorption of heat from the sun or a furnace may be much greater than the ordinary rate of heat ss, particularly in the case of a man in a black or dark garment. The conditions liable to give heatstroke are given by soldiers marching in full uniform, in close column in the sun on a calm day. Open order, stripping off of clothes, adequate water to drink, frequent rest, and a light diet are the means of prevention. White garments and helmets, and tents, reflect most sunlight, and the garments need to be open and flapping, so that ventilation is free. Shorts open at the knees, shirts open and short in the arms, and low cut and open in the neck are needed for hot climates. Aluminium foil can be used as a lining for tents to reflect sun-rays. Black or dark garments are worn in cold climates to absorb heat rays.

The cooling power of wind is enormous when the temperature is low. To resist this flying or arctic clothing consists of an outer layer of windproof material—strong, light, waterproof cloth will do—with inner layers of soft, fluffy woollens, entangling plenty of air. The garments join and even overlap, so that no wind enters at the neck, wrist, waist or ankle: a tunic with hood in one piece, gloves pulling up well over cuffs, and confined by straps, trousers coming well over tunic and confined by a belt, long boots made of supple hide coming well over trouser legs and strapped there, with soft woollen socks inside. A great trouble to arctic travellers is the moisture taken up by their sleeping-bags, which freezes by day and has to be thawed by night. Boots are best taken into the sleeping-bag to prevent them freezing. Wolverine is the fur used by Eskimos for head-cover because it does not take up the moisture breathed out.

Misty, damp atmosphere feels chilly owing to the hygroscopic properties of clothes and consequent dampness, with increased loss of body heat by evaporation of this moisture, while there is absence of radiant heat. Radiant heat from the sun and bright sky and warm ground or wall, make a great difference to comfort.

When bone dry, flannel will take up about 40 per cent of its weight of water, dry cotton or silk about half as much as wool; the physical process of the absorption of water by dry materials raises their temperature. For example, three layers of wool wrapped round the bulb of a thermometer were made quite dry in a drying-chamber. The thermometer rose 10° F. above the room temperature when it was suspended in the room owing to moisture absorbed from the air. Hence the warm feeling when well-dried clothes are put on. A woven cellular material takes up a great deal of water when wet, thus the clothing of a soldier may take up 8–9 lb. of water. To evaporate this amount would take up all the day's heat production of a sedentary worker. Woollens, owing to their elastic fibres, stick least to the skin when wet, and air still entangled in the meshes gives some protection against heat loss. Flannel is made up of 90 per cent air by volume and 2 per cent solid; smooth materials contain about 50 per cent of air. Starching and glazing make a garment almost airless, but impermeable to wind. Thus the smooth lining of an overcoat halves its permeability by wind.

While tropical clothing has a thickness of about 2 mm., winter clothing may be 12 mm. thick. The heat-retaining efficiency of clothing materials can be evaluated by means of the katathermometer. This, like the skin, is very sensitive to the cooling effect of wind. The ordinary thermometer gives the average temperature of the surroundings and is not affected by air movement. A room is comfortable when the 'kata' cooling power is 5–6. With the 'kata' clothed in a thick woollen glove the cooling power is about half what it is with the naked 'kata'. Where the so-clothed 'kata' gave readings of 3–5 and the naked 'kata' 6–10 on sunny days one can sit out in comfort in ordinary clothes. When in very cold weather the clothed 'kata' gave a cooling power of about 20, and the naked 'kata' about double as much, two overcoats, thick gloves and a muffler were needed, and even then one had to shelter from the wind to keep warm. If a rubber glove is pulled tight over the bulb of the 'kata' it gives almost no protection, but put on loose with fluffy wool underneath the protection is very great. When gloves of knitted wool, cotton, etc., are compared on the 'kata' it is evident that the nature of the fibres makes little difference. It is the air stationary in the meshes which protects. Three knitted garments put on the 'kata' bring down the cooling power to about one-third of that of the naked 'kata'. If the outermost garment be wet the protection is lessened only a little, as the cooling by evaporation from this coat is small. If a single, wet, thin, knitted glove clings to the 'kata' the rate of cooling is very greatly increased owing to evaporation. The 'kata' then becomes a measure of cooling power by convection, radiation and evaporation.

The cooling power of a wet 'kata' placed between the shirt and the skin is about trebled when a table fan is directed to blow on the body. The effect of such a fan in cooling the skin by convection and evaporation of sweat is thus made evident. The 'kata' does not actually give the cooling power exerted on the body, because it is a small bulb with a big surface in proportion to the bulk and surface of the large human body. The 'kata' cooling powers for comfort are then determined empirically. The cooling power exerted by water on the 'kata' is fourteen times that of air at the same temperature. Stirring the water makes the rate of cooling much greater. If a thick woollen glove be loosely put on and covered with a thin rubber glove, and this tied on to the stem so that no water can enter, the two coats protect the 'kata' from cooling in cold water very greatly, for example, they make it one seventh of that of the naked 'kata'. The protection becomes much less when the inner woollen glove is wet, but is still considerable. The clothes are then a protection against heat loss when one is immersed in water owing to the air entangled in the meshes, and the retention of water therein which becomes warmed by the body.

Swimming naked in the cold sea puts up the heat production of an ordinary man seven or eight times. Channel swimmers are protected by a thick layer of subcutaneous fat, which acts as an insulator, and their skin is well greased so that water cannot soak into it and increase its conductivity. Their heat production is very great owing to the powerful exercise as well as the cooling effect of water. They use up, therefore, some pounds of body fat and make this up afterwards. The heat loss of a naked man in air of 40° F. and a wind of 6½ ft. a second was found to be twice as great as when clothed. Exposed in boats or on rafts people want warm clothing and water or windproof outer garments to keep themselves from dying of cold. Such garments and enough water to drink are the two main essentials, as people when kept warm can live many days without food.

Dr. Argyll Campbell and I made observations on the rate of heat loss from the body of a subject exposed to wind and splashing of waves, either naked or in light clothing, or in such clothing plus a one-piece waterproof suit. This was made by Sir Robert Davis, of Messrs. Siebe Gorman, Ltd. The protection afforded by this suit was great, reducing the heat loss by one half. I directed the attention of the Minister of Transport to these observations, with the result that the Ministry designed a two-piece suit with a hood, all made of thin, light, oilskin material. The dress packs up in the hood, and this is carried by the merchant seamen just as a gas-mask is carried. More than 200,000 of these dresses have been issued, and the use of these contributes to the saving of life. The suit is coloured bright yellow, a colour easily seen from an aeroplane.

NATIONAL FLOUR AND BREAD

SECOND REPORT

From the Scientific Adviser's Division, Ministry of Food

SAMPLES of National flour and bread are being examined as a routine. The first report[1] covering 303 samples, of which 300 were received before 85 per cent flour became compulsory (March 23, 1942), showed that the mean values of fibre and B_1 were 0·70 per cent and 1·05 I.U./gm. respectively. The present report is a summary of the results obtained on 322 samples milled since the compulsory date together with a comparison of the quality of the flour before and after that date; it also summarizes the quality of 459 samples of bread.

Fibre and B_1. Table 1 shows the different levels of fibre and B_1 over the whole 322 samples:

TABLE 1

Fibre		Vitamin B_1	
Value %	% of samples	Value %	% of samples
⩽ 0·4	8·7	⩾ 1·10	46·6
0·5	13·7	1·00	80·7
0·6	29·8	0·90	93·5
0·7	50·6		
0·8	70·8		
0·9	85·1		

Since 85 per cent flour was made compulsory in Great Britain, millers have on occasions been allowed to admix a small amount of Canadian G.R. flour. In the period under review the average dilution in the samples received was 8·7 per cent. This would not affect the B_1 value, since the added G.R. flour is fortified to nearly the same level as National flour, but it would tend to reduce the fibre content; at a figure in the region of 0·7 per cent this reduction would be slightly less than 0·05 per cent. To compensate for this al the experimentally determined values of fibre have been increased by 0·05, although this correction, as an overall figure, is too great.

Riboflavin. Six flours taken at random from those having a fibre content of 0·7 per cent were examined for riboflavin[2], with the results shown in the second column of Table 2.

TABLE 2

Sample	Riboflavin γ/gm.	B_1 I.U./gm.	Germ content (approx.)
			%
1	1·7	1·00	1·0
2	1·9	1·10	2·0
3	1·7	1·15	1·0
4	1·7	1·20	1·8
5	1·3	1·00	1·2
6	1·7	1·15	1·0
Average	1·7	1·10	

Germ Content. In the absence of any satisfactory chemical method for estimating germ, estimates have been made based on the microscopic appearance of the flours when compared with standard preparations. The final column in Table 2 shows the results obtained with the six flours: a thorough examination was also made of twenty other flours of varying fibre content and taken at random. The same general result was obtained, the range of germ content being 1–2 per cent, with an average of 1·5 per cent. It should, however, be remembered that it is not the quantity but the quality of the germ that matters, and recent work has indicated that the dry milling of National flour will tend to retain the scutellum or vitamin B_1-rich fraction of the germ[3].

Granularity. There is no official specification for this aspect of National flour, but the Medical Research Council has advised (June 2, 1942) that all coarse bran (particles greater than 0·5 mm. cross-section) should be excluded, while the remaining particles should not have a cross-section greater than 0·2 mm. In practice this means that all the flour should at least go through a No. 5 silk. To some extent the ideal of a low fibre content and fine particle size run counter to one another, since in obtaining the maximum amount of endosperm (and least fibre) it s essential not to chop up the bran too finely. Progress, however, is being made, and the following gives a comparison of the average values obtained from he same hundred mills on samples (*A*) before, and amples (*B*) after March 23, 1942. In the case of amples (*B*) correction was made for the added G.R. flour, which was assumed to pass through a No. 10 silk.

	A	*B*
Over 32 g.g. (aperture 0·60 mm.)	3·5%	1·2%
Through 32 g.g. and over 5 silk	7·7%	6·4%
Total over 5 silk (aperture 0·27 mm.)	11·2%	7·6%

The improvement is also evident from the following figures, which show the average percentage fractions, for each successive 100 samples received, over No. 5 flour silk and No. 8 silk (aperture 0·19 mm.) respectively:

Sample No.	% over 5 silk	% over 8 silk
1–100	11·9	15·0
101–200	10·5	14·9
201–300	9·3	14·2
301–400	8·4	13·0
401–500	5·5	9·9

Comparison with Quality of Samples before March 23, 942. There are indications that the National average bre figure is decreasing and that the range of variation is becoming narrower. In order to attempt a comparison those mills which sent in samples before A) and after (*B*) March 23 have been included in a able in which each mill has been weighted on its milling capacity (sacks of flour per hour). In all, 49 mills have been included, and the following figures have been calculated for fibre:

Limit of fibre	*A* %	*B* %
≮ 0·50	10·8	26·3
0·60	30·2	46·7
0·70	56·3	75·5
0·80	79·7	86·5
0·90	92·6	90·5
1·00	96·0	99·3

A number of millers, realizing that commercial bran as such contains a considerable amount of attached endosperm, have adjusted their milling methods so as to scrape off this endosperm without chopping up the bran in the process. In this way they have been able, after prolonged experiment, to produce an 85 per cent meal with a fibre of 0·35–0·40 per cent. This technique is being followed in other mills but a limit will be set by the need for extra machinery. The following are typical samples:

	Sample 1 %	Sample 2 %
Over 5 silk	0·0	0·4
Over 8 silk	1·5	2·2
Over 10 silk	9·3	5·8
Fibre %	0·4	0·35
B_1 I.U./gm.	1·00	1·15

Quality of Bread

Four hundred and fifty-nine samples of bread have been examined. In every case a sample of the wheatmeal used was available in order to make any necessary check. The loaves were judged for quality by Dr. P. Halton and Mr. W. E. Spencer, and the following points taken into consideration: (1) general outside appearance; (2) volume; (3) crumb quality; (4) colour. Particular stress was laid on crumb quality, the standard being that of a first-quality commercial loaf. Four classes of quality were recognized—good, fair–good, fair and poor—and the following figures obtained:

Good = 278 loaves = 60·6%
Fair–good = 102 ,, = 22·2%
Fair = 58 ,, = 12·6%
Poor = 21 ,, = 4·6%

The chief defect was lack of proper fermentation and/or insufficient baking, giving a weak crumb.

The experimental work in this survey was carried out in the Laboratories of the Research Association of British Flour-Millers, St. Albans.

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[1] Research Association of British Flour-Millers, NATURE, 149, 460 (1942).

[2] E. C. Barton-Wright, NATURE, 149, 696 (1942).

[3] J. J. C. Hinton, *J. Soc. Chem. Ind.*, 61, 143 (1942).

MINERAL RESOURCES OF THE U.S.S.R.*

By DR. DAVID WILLIAMS

SINCE the inception of the first Five-Year Plan in 1927 the U.S.S.R. has made great strides towards the goal of domestic self-sufficiency in mineral supplies. Under the ægis of central authorities such as the Institute of Geology and Prospecting and the Academy of Science, thousands of geologists have been engaged in the search for new resources, playing an essential part in the industrial revolution which has swept through the Soviet Union. Although vast areas still remain to be explored, probably no country is more nearly self-supporting, and certainly none has brighter prospects of industrial and agricultural expansion in times of world peace. To some extent this favourable position is due to methods of national economy, whereby commercial considerations are subjugated to national expediency.

* Paper read on July 25 at the Conference on Mineral Resources and the Atlantic Charter, arranged by the Division for the Social and International Relations of Science of the British Association.

The most important deposits of metallic minerals lie within the ancient and deeply eroded mountain chain which extends along the Urals and then swings eastwards through Kazakhstan into Central Asia, and to a lesser extent among the younger and more rugged mountains of the Caucasus and Eastern Siberia. In the gently undulating country of the Russian platform, to the west of the Urals, enormous deposits of potassium salts and phosphate rock ensure the Union a foremost rank in the production of mineral fertilizers.

Russia's immense reserves of coal, iron and petroleum afford a sure basis for industrial progress, and in each of these three most important commodities she is capable of long maintaining a surplus output.

Iron and Ferro-Alloys

Even omitting the astronomical tonnages of comparatively low-grade quartzitic iron ores of the Kursk district, the Soviet reserves of iron ore have recently been estimated at more than 10,000 million tons, surpassing those of the United States. In 1940 Russia produced 28 million tons of ore, about two thirds of which was raised from the Ukraine deposits of Krivoy Rog and the remainder largely from Magnitogorsk and elsewhere in the Urals. Among other extensive deposits are the oolitic, brown iron ores of the Kerch Peninsula in the Crimea, the magnetites of the Kuznetsk region, and the hæmatites of Far Eastern Siberia. With such huge resources of iron ore it is clear that the Soviet Union has the opportunity not only of fulfilling her own internal demands, but also of contributing a generous export supply.

Among the ferro-alloys Russia has been, within recent years, the world's largest producer of manganese and chromite, supplying respectively about a half and a quarter of the total world output. In 1936 manganese resources were computed at more than 700 million tons, sufficient for more than 200 years output at recent levels, the chief ore bodies being the two famous deposits of Nikopol in the Ukraine, and Chiaturi in the Caucasus. Although the output of chromite has increased during the past decade, it has latterly been used almost wholly for domestic requirements of ferrochromium and chromium chemicals. The principal mines lie near Sverdlovsk in the Central Urals. Unless fresh discoveries are made, Russia may feel compelled to retain her entire production of chromite for home consumption.

Russian supplies of nickel have so far proved to be inadequate, but by exploiting several extensive low-grade nickel silicate deposits in the Urals and nickel sulphide bodies in the Kola Peninsula and in Northern Siberia, she may well become independent of imports in times of peace. According to present information, however, it is unlikely that the U.S.S.R. will ever raise a surplus supply of nickel.

For tungsten and molybdenum the Union relies very largely upon imports. Both metals occur in widely separated localities throughout European and Asiatic Russia, many promising discoveries having been reported. Workable deposits of tungsten ore (wolfram) have been located in the Transbaikal area, but no great reserves are claimed. Much is expected from the new tungsten-molybdenum concentrator at Tyrny-Aus in the heart of the Caucasus, and from other mills erected for the recovery of molybdenum in Kazakhstan and Eastern Siberia. It seems reasonable to infer that the U.S.S.R. will eventually become self-sufficient in molybdenum, though the outlook for tungsten appears to be less promising.

Non-Ferrous Metals

Russia has for long held either first or second place among the world's platinum producers, and although full statistics have not been available lately, it is obvious that she will continue to be a foremost exporter of the metal. Until a few years ago, mercury was mined only at Nikitovka in the Donetz basin, but quicksilver deposits have now been opened u in the Kirghiz, and apparently the Union's mercury supplies and demands are roughly balanced.

Aluminium was first produced by the Soviets on a industrial scale in 1932, and although productio failed to reach the projected output the amount o metal won from bauxite had risen to 55,000 tons i 1940. The hope that a total production of 200,00 tons of aluminium would be attained in 1942 canno materialize, for some of the chief hydro-electric plants (Dnieper, Volkhov near Leningrad, Kandalaksha i Karelia) are now in, or close to, enemy hands In favourable circumstances, there are good prospects of achieving and even exceeding this figure though the discernible output for some considerabl time to come will be required for domestic use Bauxite reserves, sufficient for several decades, ar estimated at 45 million tons, the largest and riches deposits lying in the Urals to the north of Sverdlovsk Immense quantities of nepheline and alunite are als available for the production of alumina and aluminium, and already plants have been erected for treating nepheline tailings from the apatite works a Kirovsk in the Kola Peninsula. The potential suppl of nepheline, which contains about 33 per cent o alumina, must exceed 100 million tons.

Although Russia produced more than 100,000 ton of copper in 1938, she also had to import approximately two thirds as much. Most of the coppe smelted hitherto has been won from Uralian deposit (notably Degtiarsk, near Sverdlovsk) but the greates ore reserves are in Central Asia, at Kounrad an Djhezkazgan near Lake Balkhash, and at Almaly in the Tashkent area. The estimated resource of copper (metal) have been placed at 16 millio tons, and although this may be an optimisti figure, it is clear that when the mines and smelte are working to full capacity there will be no nee for the Union to import any copper from abroa

Production of lead and zinc has been steadil increasing during the past twenty years. Althoug the position with regard to lead is not yet satisfactory, the zinc output is probably ample fo domestic needs. During the three years precedin the outbreak of war the imports of lead and zin averaged approximately 30 and 2 per cent respectivel of the country's total requirements of those metal Russian reserves of lead and zinc have been ca culated at 11 per cent and 19 per cent respectively the world totals, the chief deposits and refineri being in the Caucasus (Sadon) and in the Alt Mountains of Kazakhstan (Ridder, Chimkent, Sol olny, and Belousovsk). In view of the likely futu demands, there appears to be small likelihood of th Union producing a surplus of these two base metal

Up to 1937, Russia was almost wholly dependen upon imports for both tin and antimony, receivin annually about 12,500 tons of the former and mo than 2,000 tons of the latter. Apparently the mo promising of the tin-bearing areas so far prospected lies in Eastern Transbaikal, but the recorded tonnages of proved ore are not large. Reports suggest that tin smelters may soon be operating in Yakutia and Tetiukhe, in Eastern Siberia. Unless tin substitutes are developed, however, it is inferred that the U.S.S.R. must continue to rely partly on imports of the metal. Valuable deposits of antimony ore have been discovered at Kadam Djai in the Kirghiz and in Central Siberia, and it seems justifiable to expect that Russia will be able to meet her own moderate peace-time needs of antimony.

Statistics for gold production are a State secret, but it is certain that the Union has adequate resources of this precious and enigmatic metal.

Non-Metallic Minerals

Russia's position with regard to many non-metallic minerals is stronger than that of any other country.

In recent years the U.S.S.R. has been the world's largest producer of crude magnesite. The Satka deposit, near Cheliabinsk in the Central Urals, alone yielded more than 800,000 tons of the mineral in 1937; including nearby deposits, the reserves are reputed to be about 250 million tons. Hitherto most of the output has been utilized for refractory purposes, but some magnesium metal is also manufactured from Satka ore. Although the production of metallic magnesium was less than 4 per cent of the world total n 1940, the potential output is enormous, for there are extensive supplies of raw materials from which the metal can be extracted, notably the rich carnallite $KMgCl_3.6H_2O$) deposits of Solikamsk in the Western Urals, brine from various salt lakes, and the Satka magnesites.

Russian geologists claim that the prospected phosphate rock deposits of the U.S.S.R. now exceed 60 per cent of the world's resources. Near Kirovsk, in the Kola Peninsula, remarkable bodies of apatite, discovered in 1926, have recently been yielding more than 2 million tons of ore annually, with reserves for another millennium. The principal phosphorite deposits occur in European Russia, in the regions of Kirov (Phosphoritnaya) and Moscow (Egorjevsk), but an extensive and favourably situated field near Aktiubinsk in North-west Kazakhstan is being developed to supply agricultural fertilizers for western Soviet Asia.

No details of mica production have been issued since 1935, when the Union held second place in world rank. The muscovite pegmatites of the Mama-Vitim area in Eastern Siberia and the Chupa Fjord district of Karelia, and the phlogopite veins of Slyudyanka at the western end of Lake Baikal, are doubtless capable of providing adequate supplies for domestic consumption. For many years the Russian output and export of asbestos has only been exceeded by that of Canada. The yearly production of chrysotile asbestos from the well-known Bazhenov field, near Sverdlovsk, is roughly 100,000 tons, the total reserves amounting to more than 30 million ons. It is unquestionably one of the largest and most productive asbestos fields in the world.

The region of Solikamsk, on the western slopes of he Urals, has long been known for its brines and alt works, but it was only after deep boring commenced in 1925 that the remarkable deposits of potassium and magnesium salts (sylvinite and carnallite) and the enormous masses of rock salt were horoughly investigated over an area of some 700 square miles. Production started in 1932 and within five years the annual output had risen to more than two million tons of crude salts, and large quantities were being exported. Solikamsk reserves are claimed to represent about 80 per cent of the world's resources, consisting of 15,000 million tons of potash salts, 18,000 million tons of magnesium salts, and scores of thousands of millions of tons of rock salt. Even the famous Stassfurt deposits of Germany are dwarfed.

In 1938 Russia was among the leading producers of pyrite, with a tonnage approaching one million, derived chiefly from the Uralian cupriferous bodies (especially Degtiarsk) and from various coal mines. Expeditions to the Kara Kum Desert and the Gourdak Range in Turkmen territory, east of the Caspian Sea, have discovered huge supplies of native sulphur, quite comparable with the great Sicilian deposits. These Turkmen occurrences are likely to be the main future supply of sulphur, except in areas where it is being recovered during the treatment of sulphide ores.

Adequate resources of other minerals, such as graphite, fluorite and gypsum, are known to exist within the Union.

The development of mineral resources in the U.S.S.R. during the past fifteen years has far surpassed anything formerly achieved in a like period of the world's history. Sceptics may doubt the validity of some of the Russian estimates of ore reserves, but it should be recalled that vast territories still await detailed investigation and that the actual resources might well prove to exceed those now claimed. Despite the present marked deficiency in a few metals, notably tin and tungsten, it is reasonable to suppose that the U.S.S.R. will eventually become almost entirely self-supporting and may be able to export large quantities of coal, iron, petroleum, manganese, platinum, magnesite, phosphates, asbestos, potash and sulphur. The U.S.S.R., with her immense natural resources and man-power, has much to offer in the cause of world progress and welfare, and not least a share in her abundant mineral wealth.

OBITUARIES

Prof. A. Ukhtomsky

THOSE physiologists from Great Britain who had the good fortune to attend the International Congress of Physiology at Leningrad and Moscow in 1935 will remember the picturesque figure of Prof. Ukhtomsky and his novel and philosophic approach to the problems of nervous physiology. As successor to Wedensky, he had done much to develop the ideas of his brilliant teacher. It is with great regret that we now learn of his recent death in a message from Prof. K. Kekcheev addressed to the Physiological Society, on which the following notes are based.

Alexey Ukhtomsky was born in 1875 and for twenty years held the chair of physiology in the University of Leningrad, to which he was appointed on the death of his teacher, the well-known Russian physiologist Wedensky.

Ukhtomsky is known for his numerous researches into the excitation inhibition of the central nervous system. In 1911 he established the principle of the 'dominant', according to which, given the presence of any excited point in the brain, other auxiliary excitations do not call forth the usual reflexes but serve to enhance the excitation of the given point.

One of the most clearly demonstrated examples of the dominant is the substantial enhancement of the embracing reflex in male frogs at a certain season of the year when any part of the skin is excited. Several of Ukhtomsky's researches were devoted to the time factor and 'system history' in phenomena occurring in nerve tissue during excitation inhibition.

In recent years, Ukhtomsky was interested in the physiology of labour, and his laboratory, under the direction of his collaborator Prof. M. Vinogradov, was one of the centres of this science in the U.S.S.R.

The work of Ukhtomsky and his school was published chiefly in the *Proceedings of the Physiological Institute of the University of Leningrad*, of which he was editor, and in *Educational Records of the University of Leningrad*.

Prof. K. N. Moss, O.B.E.

Prof. Kenneth Neville Moss, professor of coal and metal mining in the University of Birmingham since 1922, died on October 20 at the early age of fifty-one. Prof. Moss was very active and successful in the direction of the Mining Department of the University, and was mainly responsible for the raising of £100,000 for developments in the Faculty of Science, of which for four years he was dean. A notable scheme which he carried through was the institution of a number of scholarships to attract public-school boys to the Mining Department.

Prof. Moss was educated at Queen Mary's School, Walsall, and the University of Birmingham. He had practical experience of mining in the Cannock Chase, South Yorkshire and North Staffordshire coalfields and was for a year organizer of mining education for Derbyshire. Among other positions which he had held, he was chairman of the Advisory Committee on Coal and Petroleum of the Mineral Resources Department of the Imperial Institute, president of the National Association of Colliery Managers, president of the South Staffordshire and Warwickshire Institute of Mining Engineers, and a member of council of the Institute of Mining Engineers.

During the War of 1914–18, Prof. Moss was captain and adjutant to the 59th Divisional R.E., was awarded the O.B.E. (Military Division) and twice mentioned in dispatches. The loss of his forceful personality will be severely felt by the University of Birmingham. He leaves a widow and four daughters.

G. A. Shakespear.

We regret to announce the following deaths:

Prof. Alfred Baker, emeritus professor of mathematics in the University of Toronto, where he occupied the chair of mathematics from 1887 until 1919, who was president in 1915 of the Royal Society of Canada, on October 27, aged ninety-four.

Prof. J. N. Collie, F.R.S., emeritus professor of organic chemistry in the University of London, on November 1, aged eighty-three.

Prof. J. C. Schoute, emeritus professor of botany in the University of Groningen, president of the Sixth International Botanical Congress, aged sixty-five.

NEWS and VIEWS

Educational Biology

Eminently sane, though occasionally somewhat diffuse, are Mr. Hugh Ramage's views on "Educational Biology" (*Sch. Sci. Rev.*, No. 91; June, 1942). Emphasizing the key position of biology in any adequate scheme of education, he takes the unequivocal stand that educational biology should centre upon a study of the human organism. There are many biologists who refuse to accept this view, but the author cuts a good deal of the ground away from the feet of potential opponents by his recognition of the importance of studying organisms valuable in the illustration of principles. Mr. Ramage also trails his coat on the controversial topic of sex education, but he speaks very good sense, here as elsewhere. Very salutary is his endeavour to check the swing of the pendulum away from a mere study of cadaver, before it reaches the position of the unco-ordinated study of 'function' isolated from the organism that functions. Salutary, too, is his insistence on the need for attention in school to problems of variability and ecology. It is rather difficult to be certain from this paper whether the author's outlook is that of a holist or a dialectical materialist, and indeed the teleological implications of the statement that organisms form a "purposive" entity (albeit with inverted commas) give ground for suspicion that perhaps Mr. Ramage takes up no consistent philosophical position. But he poses clearly here many problems of educational method which should receive the attention of all teachers.

Engineering in Agriculture

In his presidential address to the Institution o Civil Engineers delivered on November 3, Sir John Thornycroft pointed out that his work has been so closely connected with the Navy, and to a smaller extent with the Army, that he considered it inadvisable in present circumstances to talk about it, as has usually been done by presidents of the Institution He has, however, taken a great personal interest in engineering in agriculture, and he devoted his address to that topic. From the earliest times the engineer has played a very important part in helping the agriculturist in irrigation, drainage, land reclamation and in the provision of implements which enable men, with the aid of oxen and horses, to do so much more than was possible with the primitive hoe and mattock. The address dealt in detail with the problems of land drainage, soil erosion, and the application of steam and internal-combustion engines to tractors and farming machinery—ploughs, machines for sowing seed in drills and for planting root crops and potatoes, and harvesting machines. The importance of research was emphasized and mention was made of the establishment by the Government of the Agricultural Machinery Development Board and o an Institute of Research in Agricultural Engineering A very large home-grown sugar industry has been built up in Great Britain in recent years, and the British Sugar Corporation has contracts with more than 52,000 farmers, who provide 400,000 acres o the crop; the whole of the domestic sugar ration allowed in Great Britain at present is home-grown. The application of electric power was discussed and its extension urged, with a suggestion that town dwellers and industrialists should be charged an overriding percentage so that supply companies would be able to distribute current to every agricultural holding at the low prices available to town dwellers.

Agriculture To-day and To-morrow

THE Royal Society of Arts has arranged a special series of ten lectures on "Agriculture Today and Tomorrow", beginning on November 11. In organizing these lectures, the Society is carrying on what was for nearly a century one of the most important branches of its activities. At the time of the Society's foundation—1754—the methods of agriculture were practically those of the Middle Ages. Until the inauguration of the Royal Agricultural Society in 1838, the Society's Committee of Agriculture under Arthur Young was the most important body in Great Britain concerned with the welfare of agriculture. Under its auspices many improvements were made in agricultural practices. The Society also opened to the public its "Repository of Inventions", which contained an excellent collection of models of agricultural implements, and in 1761 it held an exhibition of agricultural machines. Although the present lectures are intended mainly for those actively engaged in agriculture, it is emphasized that the series will be of interest to laymen. A syllabus of the series can be obtained from the Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

Utilization of Rural Waste

FOLLOWING on the article by Mr. Bransby Williams on the manufacture of fertilizer from urban wastes (NATURE, Sept. 5, p. 299), it is interesting to note that an experiment in rural sanitation is being conducted by Dr. A. T. Westlake on his estate at Sandy Balls, near Fordingbridge. The estate is used as a holiday centre, and a large number of visitors, living in huts, caravans, and tents, pass through it in the course of the year, in addition to a resident population of about forty persons. The Poore method was at first tried, but later Dr. Westlake adopted the Indore composting system of Sir Albert Howard with good results. All the night soil and other refuse on the estate is composted in heaps. There is separation of solids and liquids. By the use of specially dried earth and leaf mould, the collection and handling of the material is rendered efficient, easy, and hygienic. In winter the method so far adopted has been the use of small composting pits. The matured compost is used to manure what was formerly barren ground, but which has now become a healthy and flourishing kitchen garden. Plant disease has been very largely eliminated. It is clear from the experiment that the methods used here might well be tried in other rural communities.

Engineering Cadetships

THE Government announces the foundation of engineering cadetships, open to youths of sixteen to nineteen years of age, inclusive, and leading to technical commissions in the fighting services. The Government will pay the necessary educational fees and allow each cadet a maintenance grant. Youths of 16–19 are invited to apply if (*a*) they left school before October of this year; (*b*) are not employed in any branch of engineering; and (*c*) have obtained at least the school certificate with a credit in mathematics or general science or physics or an equivalent examination. The length and character of the training, which will be at a technical college, will be adjusted to age and educational qualifications, and may extend to two and a half years. Boys of sixteen will have preliminary instruction at a technical college or other appropriate institution. The training courses will cover the basic engineering science required in the associate membership examinations of the Institution of Mechanical Engineers or the Institution of Electrical Engineers. In the case of the Institution of Mechanical Engineers, cadets who successfully complete their course will be exempted from sections A and B of the associate membership examination. Youths of eighteen who have been called up may apply for cadetships, and boys born in 1924 and still at school may also be accepted. Applications will be received by local appointments offices of the Ministry of Labour and National Service or by the Appointments Department, Sardinia House, London, W.C.2.

Russian-English Technical Glossaries

As a result of the appeal by Sir John Russell, chairman of the Anglo-Soviet Scientific Collaboration Committee, for Russian-English technical dictionaries, sixteen glossaries of Russian technical and scientific terms have been collected and placed in the Science Library, South Kensington, London, S.W.7, where they are available for consultation. Most of the glossaries, which cover a wide range of subjects—military and naval terms, metallurgy, medicine, botany, fuel technology and bacteriology of fish—have been compiled by individuals during the course of their work in a special field. Some are printed, others are typed or in duplicated form, while others are in manuscript or on cards. A list of these glossaries giving the name and address of the compiler or donor can be obtained from the Secretary of the Anglo-Soviet Scientific Collaboration Committee, British Council, 3 Hanover Street, W.1. A location list of Russian technical glossaries has also been compiled by the Anglo-Soviet Scientific Collaboration Committee. This list, which incorporates the glossaries collected for the Science Library, also indicates the libraries in which copies of the chief Russian scientific and technical dictionaries may be found. Copies of the location list may also be obtained upon application to the Secretary of the Anglo-Soviet Scientific Collaboration Committee.

Map of Europe and Middle East

A MAP of Europe and the Middle East on a scale of 1 : 11 million has been published by the Royal Geographical Society on behalf of the British Council. The map is drawn on Murdoch's third conical projection and extends from Western Europe, the British Isles and Iceland east to Rangoon and south to Abyssinia. It will fit obliquely with two adjoining sheets, North America to Britain and the Far East, which are now published in outline only but are to be completed later. Land relief is shown by contours and layer colouring in tints of brown and hill shading in lavender grey corresponding to a light thrown from the top left-hand corner of the plate. Contours are at 50, 100, 200, 500, 1,000 and subsequent 1,000 metres, which is fully as many as the scale can bear in some areas. Principal railways are shown as red lines and selected roads as red dotted lines. Political boundaries as in 1938 are marked and there are also shown oil fields, pipe lines, ancient sites, deserts, marshes and glaciers. No submarine relief is shown: water is blue. Names of countries and principal rivers and towns are in black. An edition with names in Arabic is to be published. The present sheet (No. 1), flat or folded, costs 5*s*., or, flat, with the outline edition of No. 2 and No. 3, which are not sold separately, 8*s*.

Sir Robert Kane

UNDER the auspices of the Chemical Society of University College, Cork, Mr. D. Ó. Raghallaigh has recently issued an interesting booklet of forty-three pages dealing with the life and work of Sir Robert Kane (1809–1890), a pioneer of chemistry and of industry in Ireland. Kane studied medicine at Trinity College, Dublin, and became professor of chemistry at the Irish Apothecaries' Hall at the age of twenty-two. After his appointment to the chair of natural philosophy at the Royal Dublin Society in 1834, he published his important work on ammoniacal compounds of mercury, copper and zinc. This was followed in 1840 by a research on the colouring matter of lichens, and soon afterwards Kane was elected F.R.S. His "Elements of Chemistry", completed in 1843, achieved fame as a standard text-book. He took far-sighted views of Irish industries and agriculture; for example, he directed attention to the chemical potentialities of Irish peat and potatoes, and depicted the Shannon Valley as the future industrial centre of Ireland. In organic chemistry he accomplished the first synthesis of a cyclic compound (mesitylene) from an open-chain one (acetone). In 1845 Kane became the first president of the new Queen's College, Cork, and in the following year he was knighted for his services to science and Irish industry. After his resignation of the presidency in 1873 he became first dean of the Royal College of Science for Ireland, and later he was appointed vice-chancellor of the Royal University. One of Kane's sons commanded H.M.S. *Calliope* in the historic escape of this ship from Samoa Harbour during the hurricane of March 15, 1889.

Wood-Pigeon Investigation

THE third Bulletin of the Wood-pigeon Investigation, issued by the Edward Grey Institute of the University of Oxford, covers some of the findings of the past nesting season, and the expansion of the investigation to have 500 observers recording 250 birds a month next breeding season, thus recording more than a million birds. In some parts of Great Britain during 1942 the birds were very sparse with only one or two nests in a hundred acres, and in others their nests were sufficiently concentrated to show definite breeding colonies with preference for certain areas. The most densely populated haunts were young spruce plantations. At the peak of the breeding season in August (it is much later than with most birds) these dense haunts had as many as twenty nests in four acres. At the end of September there were still 10–20 nests occupied in some plantations. Many districts had more occupied nests in July than in June.

It is hoped to gain a better knowledge of the distribution of the nesting colonies throughout Great Britain in order to understand how they came to exist. The life of a wood-pigeon is long, but it is desired to know how long and how it varies with different types of woodland. The breeding season of the wood-pigeon does not necessarily coincide with that of other woodland birds. The possible connexion between late breeding and the formation of colonies is to be investigated. In the winter countryside, as in the nesting season, the wood-pigeon population is not evenly distributed. The filling in of record cards of winter flocks can give their distribution month by month, as well as their autumn, winter and spring movements, and a seasonal guide to feeding-grounds and flock sizes, favourite feeding hours and the relative number of stock doves feeding in the flocks. A collection of photographs is also being built up of nests, crop damage, and 'colony' woods.

Biology of Oysters

THE oysters of Australia are being thoroughly investigated by the Division of Fisheries, Council for Scientific and Industrial Research. In the first of the series of pamphlets on the biology and cultivation of oysters in Australia, G. A. Kesteven wrote on some economic aspects (Pamphlet No. 105; 1941). A more recent publication, in two parts, is by G. Humphreys (2. A Note on the Calcium Content of Some East Australian Waters; 3. Biochemistry of the Proximal Constituents. Commonwealth of Australia. Council for Scientific and Industrial Research, Division of Fisheries. Report No. 7. Pamphlet 111. Melbourne, 1941). The calcium content of a number of oyster-growing waters has been investigated and the relation between condition and the fluctuation in the proximate constituents of the oyster, namely, carbohydrate fat and protein. It is concluded that there is no essential difference in calcium content between waters where oyster growth is normal and waters where only stunted growth appears. Opinions differ as to the role of glycogen in the oysters, some maintaining that it determines fatness, others that it is a reserve food material. The author shows that the latter view is correct, for the fattest oysters occur just before spawning when the glycogen percentage is at its minimum. The idea, supported by recent investigators, that glycogen is stored as a reserve food material and is used for the formation of gonad products which do not consist of glycogen is borne out by the figures presented, in which it is seen that for healthy oysters the glycogen percentage is in the range 3–7 during most of the year, but that just when the oysters are about to spawn, the value is below 2. It is found that oysters can be dried with no loss of glycogen or protein.

Impregnating Varnishes

W. J. KIERNAN points out in a recent article (*Bell Lab. Rec.*, **20**, No. 12; August 1942) that until the recent development of synthetic resins and drying oils the impregnants applied to coils contained linseed or china-wood oils and natural resins, and that they 'set' by surface oxidation, leaving the interior in a semi-fluid state. Fatty acids were usually present in the unset portion, sometimes in sufficient strength to corrode copper. Varnishes made with synthetic resins of the phenol-aldehyde type polymerize on drying rather than oxidize, and produce a solid state throughout their mass. Corrosive tendencies are negligible or entirely absent because of their complete setting and low acid content. When thoroughly dried by baking at high temperatures, they are no longer thermoplastic. This allows coils to operate at higher temperatures without softening the impregnating material and permits substantial savings by reducing the size of the coils. The penetrating power of these synthetic resins and their high dielectric strength make them particularly valuable for high-voltage circuits where corona discharges might occur and, by oxidizing the nitrogen, produce nitric acid which breaks down the coil insulation. Retardation coils and power transformers of several types, designed for telephone apparatus, are now being impregnated on a production basis with synthetic resin varnishes. The results indicate advantageous possibilities for their wider use.

Tuberculosis Control in Argentina

ACCORDING to Dr. Hugo J. D'Amato, secretary of the National Department of Health of Argentina (*Bol. Of. San. Panamer.*, 21, 772; 1942), family contacts have been examined in the last few years at the tuberculosis dispensaries of this department in order to discover unrecognized cases. As this procedure, however, did not include extra-familial contacts a new organization is being planned which will involve systematic and repeated examinations of the entire population. At present all public employees and all applicants for Government positions have to undergo clinical and radiological examinations of the thorax as well as tuberculin tests. Of 10,863 persons examined 104 were rejected and 51 were accepted with a temporary certificate while under treatment. Only six of the 10,708 applicants declared to be healthy or 60 per 100,000 have developed tuberculosis in the course of two years, whereas before examination was made compulsory the rate of infection was 520 per 100,000. In August 1941 the National Commission of Tuberculosis was created, which besides centralizing the administration of the tuberculosis control campaign, has power to propose measures regarding salaries, housing, nutrition and industrial hygiene.

Earthquakes Registered in Switzerland

DURING July and August 1942, thirty earthquakes were registered by the instruments at the Swiss observatories of Zurich, Chur, Basel and Neuchâtel (*Swiss Earthquake Bull.*, No. 146 and No. 147). The distant earthquakes have, for the most part, been mentioned previously in the columns of NATURE, but the local earthquakes have not. On July 1 an earthquake was felt with intensity V (Rossi-Forel scale) in the Pays d'Enhaut. It was registered at Zurich at 23h. 43m. 13·3s., the epicentre being some 135 km. distant. On July 17 an earthquake was registered at Chur at 10h. 27m. 08·8s., which had its epicentre in the Schwäbische Alb, and on July 18 an earthquake registered at Basel at 15h. 46m. 08·3s. had its epicentre less than 10 km. to the north-west of that station. The earthquake of August 27, registered at Zurich at 11h. 11m. 21·9s., had its epicentre 70 km. from that station and was felt in the neighbourhood of the Brünig and Lungernsee. Finally, the earthquake of August 28, registered at Zurich at 11h. 28m. 58·4s., had its epicentre 71 km. from that place and was felt with intensity V in the neighbourhood of the Hohenstollen.

An Important Binary Star System

DR. R. M. PETRIE, of the Dominion Astrophysical Observatory, Victoria, B.C., reports the discovery of another sub-dwarf star, a component of the binary system *HD* 144208–9 (*Sky and Telescope*, August). The primary in the system is of class *G* and the dwarf is of class *A* and a normal object for its class. Its luminosity in terms of the primary was determined from the combined spectrum of the two stars, in which the metallic lines and the *K* line of calcium are weaker than normal, and the wings of the Balmer hydrogen are stronger. The assumption that the primary obeys the mass-luminosity relation—mass proportional to absolute magnitude—made it possible to determine the masses and mean densities of both stars. Many other binary systems exist in which the components are *G*- and *A*-type, and the investigation of these systems is important that more may be understood about the relationship of the sub-dwarfs to the white dwarfs.

A Radiological Library

A RADIOLOGICAL library valued at £3,500 is on sale by the Museum Book Store, 45 Museum Street, W.C.1, by whom a 12-page pamphlet is issued. This world-wide collection of journals and periodical publications, each in the language of its origin, is not likely to be duplicated, and it is hoped that it will find its way into some research laboratory or radiological centre. The chief publishers of radiological subjects have been the United States, Germany, France and Great Britain, and we can think of no X-ray or radium journal which is not included in this library. This offer of sale has now been open for some months and the step of acquiring the valuable collection waits to be taken by some authority with vision as well as money.

Prof. F. H. Garner

THE chair of oil engineering and refining in the University of Birmingham, rendered vacant by the death of Prof. A. W. Nash, has been filled by the appointment of Dr. F. H. Garner, a graduate of the University (1914). Dr. Garner was for many years chief chemist of the Anglo-American Oil Co. and is that company's principal scientific officer in Great Britain; he has a high reputation and an excellent record as a research chemist in the field of oil chemistry. He has acted as an external examiner in the Oil Engineering Department of the University of Birmingham for several years and has thus a knowledge of the working of the Department.

Announcements

THE Emil von Behring prize, which is awarded by the University of Marburg every two years for outstanding achievements in immunology, serum therapy and chemotherapy, has been awarded to Prof. Paul Uhlenhuth, professor of hygiene and bacteriology in the University of Freiburg-im-Breisgau.

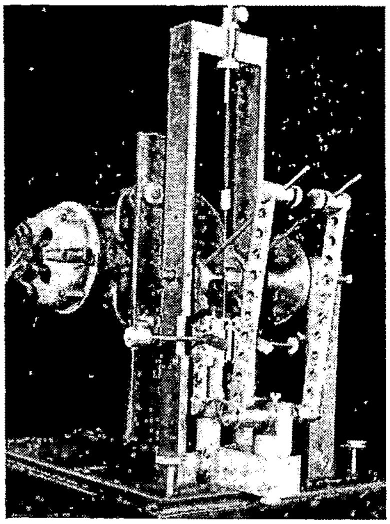
WE have received *Abstracts of Articles and Patents on the Production of Glycerol by Fermentation* published by the National Research Council of Canada, Ottawa, 1942, which contains abstracts of 109 articles and 114 patents on this subject. The publication is N.R.C., No. 1070, price 50 cents.

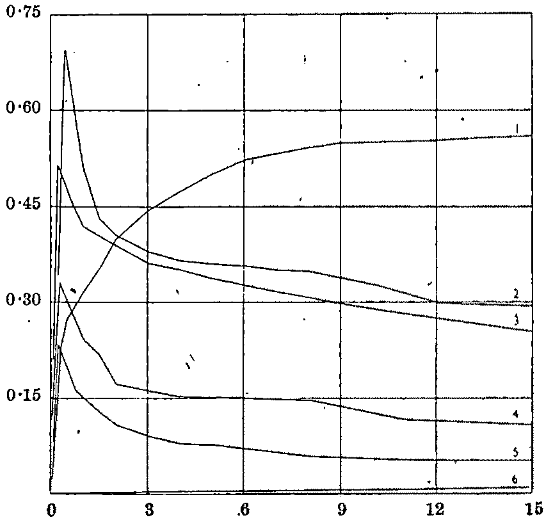
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Scaliness of Animal Fibres

One of the most important properties of wool fibres is their ability to migrate in the direction of the root end when rubbed, especially in presence of a solution of soap or acid. With fabrics and masses of loose fibre, migration takes place in much the same way as a worm crawls[1], and is due primarily to the surface scale structure of the fibres. This peculiarity is turned to advantage in the manufacture of felts, and to meet an obvious need, a method of measuring the scaliness of different types of fibre was devised some years ago[2]. It consists in mounting fifty fibres in parallel, with the scales all pointing in one direction, and then measuring the frictional resistance to motion towards the root ends and towards the tips of the fibres. The observed difference in (static) friction in the two directions gives a measure of scaliness. Although the method has given useful results, it suffers from a number of defects. Besides being tedious in use, it gives no opportunity of studying the properties of individual fibres, and is not very closely related to the practice of felting, where dynamic friction is operative.





1, Human hair. 2, New Zealand Romney wool. 3, Lincoln wool. 4, Cotswold wool. 5, Mohair. 6. Kemp (from Blackface fleece).

To overcome these defects, a new method of measuring scaliness has been evolved. The apparatus is shown in the illustration. A single fibre, with the tip-end uppermost, is rubbed at a standard rate between two opposed, reciprocating, plane surfaces under controlled pressure, the surfaces being clothed with silk bolting-gauze or other suitable material. The fibre creeps downwards against a gradually increasing tension in the calibrated spring, to which its tip-end is attached. A measure of scaliness is given by the rate of increase of tension and by the maximum tension developed, allowance being made, if necessary, for variations in fibre diameter.

Typical curves showing the rate of development of tension with various fibres are reproduced. They reveal an interesting phenomenon. Whereas the maximum tension developed in the case of human hair is maintained over long periods of rubbing, the various wools examined show a rapid fall in tension as soon as the maximum has been attained. Besides possessing different degrees of scaliness, therefore, animal fibres clearly vary in their resistance to abrasion. Both factors, the second of which has hitherto been neglected, must play a part in determining the felting power of different wools, and their mode of operation under different conditions of humidity, temperature and pH is now being studied with the new apparatus.

N. H. Chamberlain.
J. B. Speakman.

Textile Chemistry Laboratory,
University, Leeds.

Oct. 17.

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[1] Arnold, *Leipziger Monats. für Textilind.*, 44, 463, 507, 540 (1929); Speakman, Stott and Chang, *J. Text. Inst.*, 24, T273 (1933).

[2] Speakman and Stott, *J. Text. Inst.*, 22, T339 (1931).

Vitamin Requirement of the American Flour Beetle *Tribolium confusum* Duval

The larvæ of the American flour beetle *Tribolium confusum* Duval can only develop on a diet consisting of protein, carbohydrate, salts, and water if yeast or some other suitable vitamin source is added[1]. Fröbrich[2] found the addition of 5 per cent of dry yeast to a diet of casein, rice starch and Osborne-Mendel salt mixture in a relative humidity of 70–75 per cent to be sufficient. For the activity of the yeast extract thiamine, riboflavine, and an unknown factor B_x were important; in the insoluble fraction there were recognized as necessary ergosterol (which could be replaced completely by cholesterol) and a further unknown factor, U. Offhaus[3] obtained similar results with a diet of dried egg-white, rice starch, and di-potassium hydrogen phosphate, but found that the insoluble yeast fraction could be completely replaced by cholesterol + histidin. Fraenkel and Blewett[4] have also investigated this problem.

During the past two years we have carried out experiments with Tribolium larvæ, which have furnished somewhat different results. One-day-old larvæ in groups of five were kept at 34° in a relative

TABLE 1.

Diet: 1·5 gm. given	No. of animals observed	Results after 22 days			Growth response
		Larvæ	Pupæ + Adults	Dead	
(*a*) Wholemeal	5 5	– –	5 5	– –	Good
(*b*) Deficient diet	5 5	5 5	– –	– –	None
(*c*) Deficient diet + 75 mgm. dry yeast	5 5	– –	5 5	– –	Good
(*d*) Deficient diet + 37 mgm. insoluble yeast	5 5	5 5	– –	– –	None
(*e*) Deficient diet + 37 mgm. yeast extract	5 5	5 5	– –	– –	None
(*f*) Deficient diet + 37 mgm. insoluble yeast + 37 mgm. yeast extract	5 5	– –	5 5	– –	Good

humidity of 70–75 per cent on 1·5 gm. of a deficient diet, and the pupæ counted after 22 days. The deficient diet consisted of 20 per cent casein (vitamin-free), 75 per cent rice starch, and 5 per cent McCollum salt mixture. Dried brewer's yeast was boiled for 2 hours with 5 parts of distilled water, the treatment repeated nine times, and the insoluble fraction dried. The united aqueous extracts were largely evaporated *in vacuo*, alcohol added to give an alcohol content of 80 per cent, the precipitate removed, and the clear filtrate evaporated *in vacuo* and dried (yeast extract).

TABLE 2.

Diet: 1·5 gm. given	No. of animals observed	Results after 22 days			Growth response
		Larvæ	Pupæ + Adults	Dead	
(*a*) Wholemeal (control)	5 5	– –	5 5	– –	Good
(*b*) Deficient diet + 35 mgm. insoluble yeast + 10 addenda*	5 5	– –	5 5	– –	Good
(*c*) Deficient diet + 37 mgm. insoluble yeast + 3 addenda**	5 5	– –	5 5	– –	Good
(*d*) Deficient diet + 35 mgm. insoluble yeast + 2 vitamins*** + 0·25 γ biotin (pure)	5 5	– –	5 5	– –	Good
(*e*) Deficient diet + 35 mgm. insoluble yeast + 2 vitamins*** (without biotin)	5 5	5 5	– –	– –	None
(*f*) Deficient diet + 100 γ cholesterol + 3 addenda**	5 5	– –	5 4	– 1	Good
(*g*) Deficient diet + 100 γ cholesterol + 2 vitamins*** + 0·25 γ biotin (pure)	5	–	–	5	None

* 10 Addenda : 10 γ thiamine, 8 γ riboflavine, 10 γ pyridoxine, 5 γ calcium pantothenate, 500 γ nicotinic acid amide, 2 mgm. *meso*-inositol, 1 γ *p*-aminobenzoic acid, 10 mgm. SiO_2, 10 γ KI, 15 mgm. biotin preparation from liver (= 0·3 γ pure biotin).

** 3 Addenda : 10 γ thiamine, 500 γ nicotinic acid amide, 15 mgm. biotin preparation from liver (= 0·3 γ pure biotin).

*** 2 vitamins : 10 γ thiamine. 500 γ nicotinic acid amide.

The separation of the active constituents was complete (Table 1).

It was then found that the 37 mgm. of yeast extract could completely be replaced by a mixture* (Table 2, *b*) of the ten components of which only the biotin preparation was non-homogeneous. By omitting individual components it was shown that two pure vitamins**, namely, thiamine and nicotinic acid amide, together with 15 mgm. of a biotin preparation (= 0·3 γ biotin) were sufficient (*c*). The biotin preparation in this combination*** could be replaced by an equivalent quantity of pure biotin (*d*), the necessity of which was again demonstrated (*e*).

By using the three-component mixture** as the vitamin source, the insoluble yeast fraction could completely be replaced by 100 γ cholesterol (*f*); this could not be accomplished by use of the two crystalline vitamins*** with pure biotin (*g*). Thus the water-insoluble yeast fraction contains at least one other factor which is necessary for the development of Tribolium, and which is also present in our biotin preparation from liver.

Our results confirm the necessity of biotin, but differ sharply from those of Fraenkel and Blewett. This difference could arise from the different basic diets or from the different animal strains employed. The circumstance that our experiments and possibly those of the other authors were not conducted under aseptic conditions appears to us more important; thus, although no sign of infection was observed, living micro-organisms in the digestive tract could play an important part as producers of vitamins. One of us (H. R.) desires to acknowledge the assistance of the "Roche" Studien Stifting, which enabled him to take part in this work.

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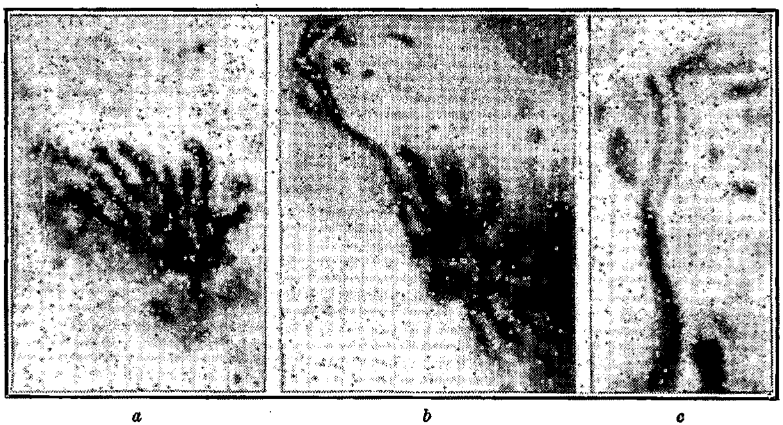
Demonstration of the Telophase Split in Todea

THE time of chromosome splitting in a normal cell division is, and has long been, one of the most hotly controversial topics in the whole of cytology. Two extreme views hold sway. According to one, a chromosome is single at all stages of mitosis except prophase and metaphase, the split itself occurring at the end of rest (cf. Darlington[1], White[2], and others). According to the other, a chromosome is at no time single, the prophase split being already formed at the preceding telophase or earlier; indeed in some plants with large chromosomes, notably Trillium and Tradescantia, both pro- and telophases have recently been described as visibly quadripartite (cf. Nebel[3] for the most recent available summary of this point of view).

Historically, both views go back to the last century, as may conveniently be seen by comparing early and late editions of a classic handbook such as that of Wilson on the cell[4]. Throughout this period the factual basis of both views has suffered repeated confusion and contradiction owing to uncertainties in other fields; ignorance of the facts of spiral structure and preliminary difficulties regarding the morphology of chromosome pairing being two of the



PHOTOMICROGRAPHS OF SISTER NUCLEI NEAR THE CLOSE OF A MITOSIS IN A YOUNG PROTHALLUS OF *Todea barbara*, FROM A LIQUID MOUNT IN ACETOCARMINE. *a* AND *b* × 2000; *c* × 4000.

most outstanding causes of conflict. The controversy is of importance because its solution is indispensable to a clear understanding of many larger problems involving a knowledge of chromosome structure. The literature is far too voluminous to be quoted in detail though a guide to it will be found in the works above cited; but the present position may perhaps be summarized by the statement that the older and simpler 'prophase split' view is the one more frequently expressed by modern British writers though, perhaps significantly, the most emphatic expositions of it are to be found in works with a strongly theoretical bias. On the other hand, the observations carried out in the last decade on spiral structure of chromosomes, especially in Japan and in America, has led an increasing number of observers in those countries to accept the theoretically more complex 'telophase split' view.

A problem such as this can scarcely be approached with profit except in relation to new and incontrovertible evidence. Some evidence of this kind is thought to be contained in the accompanying photographs.

The photographs are from a cell near the close of the third division in the germinating spore of the fern *Todea barbara*. The specimen had been treated for spiral structure, fixed in acetic alcohol overnight and then mounted and squashed out of its cell wall in a drop of warm acetocarmine by momentary pressure on the coverslip. It was observed and photographed in this reagent after ringing the preparation, but was afterwards successfully brought into Canada balsam and is still available for study.

In the accompanying illustration, *a* represents the upper of two sister plates of chromosomes at late anaphase or early telophase. Beyond traces of spiral structure which will be described elsewhere it shows nothing remarkable. *b* represents the corresponding, lower, plate of chromosomes. It lies at a deeper focal level and appears to have encountered some mechanical impediment in the act of squeezing out of the torn cell wall, for two chromosomes (now lying somewhat across each other in the top left-hand corner of the picture) have been violently distorted by stretching. In one of these (the apparently longer) not only has the spiral become almost effaced by this process but also, more important, for a considerable distance near its end, two distinct and separate threads have been forced widely asunder. The significant part of this chromosome is shown at a higher magnification in *c*.

While freely admitting that the ease of separation of the two threads in this chromosome is likely, in part, to be due to the treatment, I find it impossible to believe that the split itself is an artefact, it being remembered that until the pressure was applied to the coverslip the chromosome was in the form of a complex spiral. I am therefore of opinion that this one specimen is conclusive evidence that the telophase split is a reality for the plant under investigation.

Further discussion of this and other conclusions to which the specimen gives rise will be dealt with elsewhere.

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A Water-soluble Carcinogen Derived from 3 : 4-Benzpyrene

IN a note entitled "Photo-oxides of Carcinogenic Hydrocarbons", an account has already been given of the labile water-soluble materials produced from 3 : 4-benzpyrene by irradiating it in solution in benzene, and of some biological effects produced by them[1]. Similar materials were shown by Schulman and Rideal to be adsorbed on protein monolayers[2], and by analogy with their work on œstrogenic and hæmolytic substances, it appeared possible that the existence of such water-soluble derivatives might throw light on the mechanism by which tumours are produced by the insoluble parent hydrocarbon. Further investigation of the optimum conditions for the irradiation, in collaboration with Dr. B. Szigeti, of the Research Department of Messrs. Adam Hilger Limited, has made it possible to prepare more concentrated extracts from irradiated benzpyrene than were used in the earlier experiments, and these have proved to be carcinogenic.

1·5 ml. of a 1 per cent solution of 3 : 4-benzpyrene in benzene was diluted to about 20 ml. with a mixture of benzene and cyclohexane containing upwards of 20 per cent of benzene. (In view of the restriction of supplies of the pure solvents, the exact proportions have had to be decided on the basis of the materials available. Optimum results are obtained with 20 per cent benzene.) This solution was irradiated for 30 minutes in an open dish 260 cm.^{2} in area placed immediately below a neon-sensitized mercury lamp which gives almost pure monochromatic ultra-violet light of wave-length 2537 A.[3]. The remaining solvent was evaporated quickly in a current of air, and the dry residue was extracted with about 4 ml. of *M*/100 sodium bicarbonate solution. The extract was filtered free from unchanged benzpyrene and from insoluble products of the irradiation.

0·15 ml. of the filtrate was brushed into an area 2 cm. in diameter on the backs of ten mice from a stock in which no spontaneous tumours have occurred over a period of several years. 260 paintings have been given in fifty-four weeks. Five mice have developed tumours on the painted site, and in four cases so far examined histologically, these consisted of multiple keratinizing squamous cell carcinomas with small papillomas.

In order to exclude the possibility that the effect might be caused by the passage of colloidal benzpyrene through the filter, ten control mice have been painted simultaneously with a solution prepared in the same way but without the irradiation. The control has also been weighted against the experiment by adding acetone to the solution to ensure its rapid penetration into the skin. Five of the control animals have been examined (up to fifty-four weeks of painting): none of them has shown any cancerous or precancerous condition. It may therefore be concluded that the aqueous extract from 3 : 4-benzpyrene contains a carcinogen which is not the hydrocarbon itself.

This conclusion is supported by evidence obtained in experiments in which mice previously sensitized by applying a solution of benzpyrene in benzene have been painted on the same site either with the aqueous extract or, for control, with bicarbonate solution. Twenty out of twenty-eight experimental mice have developed tumours in periods varying from thirty-eight to fifty-four weeks of painting as compared with four of the twenty-eight control animals.

It is impossible at present to identify the active compound. The aqueous extract contains two main substances characterized, at *p*H 8, by absorption bands at 3600 A. and 2760 A. respectively, but all attempts to isolate them have led to decomposition. Similar—possibly identical—substances have been detected in the products of irradiation, under the same conditions as were described in the earlier note[1], of cholanthrene, 1 : 2 : 5 : 6-dibenzanthracene, phenanthrene, anthracene and of naphthaene. The absorption spectra exclude the possibility that they are either photo-oxides[4], mono- or dihydroxy derivatives[5], or of the stilbene type[6].

This work has been maintained by grants from he Medical Research Council, to which I express my indebtedness. I also thank Dr. H. B. Fell and Prof. E. K. Rideal for their continual advice and interest, nd Dr. A. Glucksmann for undertaking the histoogical examination of all the material.

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Lichenin

THE introduction of cross-linkages into soluble synthetic linear high polymers is followed by a decrease in solubility. In Nature, an interesting parallel appears to be afforded on one hand by the water-soluble polysaccharide lichenin, which consists of an unbranched β-glucopyranose chain $(C_6H_{10}O_5)_n$ where $n = 80–160$ [1, 2] and by cellulose on the other, if for the latter the structure of β-glucopyranose chains (or multi-membered loops) linked at intervals by cross-linkages[3] be accepted. This communication contributes to the question of the structural difference between lichenin and cellulose.

It has been shown previously[4] that treatment of potassium hydroxide-cellobiose with dry methyl sulphate followed by hydrolysis yields 2-methyl- and 2 : 6-dimethyl glucose whereas potassium hydroxide-cellulose when treated in this way yields 2-methyl glucose, but no 6-methyl or 2 : 6-dimethyl glucose[5]. This seems to indicate that in cellulose the primary alcohol residues are not vulnerable to attack under these mild conditions, and is evidence that the primary alcohol residues are the most likely to be involved in some form of cross-linking between the chains.

We have now shown that lichenin can combine with one molecular proportion of potassium hydroxide for each anhydroglucose unit to form an unstable addition compound, but that both 2- and 6-methyl glucose are present in the products of hydrolysis after methylation under anhydrous conditions. This result may be interpreted as showing that the primary alcohol groups in lichenin are not shielded as in cellulose and is in harmony with the results of Carter and Record[1] who, by their osmometric measurements on acetylated and methylated lichenins, show that the 'physical' molecular weight is of the same order as that found by end-group assay; that is, there is no aggregation of primary chains by cross-linkages, and thus agrees with the suggestion of W. N. Haworth[3].

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Artificially Induced Loss of Theta-Toxin Production by *Clostridium welchii* Types *A* and *C*

Macfarlane and Knight[1] having shown fairly conclusively that the alpha toxin of *Cl. welchii* Type *A* is a lecithinase, we considered it possible that repeated passage through media containing lecithin might enhance the capacity to produce alpha toxin. However, we found that after a dozen rapid passages through Hall's cooked-brain medium, strains showed no loss of capacity to produce alpha toxin when grown in 'test medium' (V.F. broth plus 0·25 per cent glucose), as compared with the same strains after similar passaging through test medium, but that they unexpectedly lost the capacity to produce theta toxin. It would thus appear possible to produce large quantities of *Cl. welchii* toxins free from theta toxin, much more simply than by the procedures described by van Heyningen[2]. Strains of *Cl. welchii* Type *C*, which normally produce considerable amounts of theta toxin (up to 1,000 H.U. per ml.), behaved in the same way.

It is of some interest to note that this procedure did not at all affect the capacity of Types *A* and *C* to produce proteinase. This suggests that theta toxin is not identical with the gelatinolytic proteinase, which, like it, is activated by cysteine.

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The E. M. F. of Thermal Fluctuations in Resistances

THE formula giving the mean-square E.M.F. of thermal fluctuations per cycle, in a resistance R at temperature T, namely:

$$\overline{e_\nu^2} = 4 . R . k . T, \qquad (1)$$

was first derived by Nyquist[1] by thermodynamical reasoning.

J. Bernamont[2] has derived formula 1 from the corpuscular point of view, using the Lorentz theory of electrons. The mechanism of the conductivity by free electrons was considered, both with the classical statistics of Boltzmann and the quantum statistics of Fermi-Dirac.

C. J. Bakker and G. Heller[3] have shown that to specify Boltzmann or Fermi-Dirac statistics is unnecessary and that equation 1 can be obtained by application of the most general statistical consideration. The following derivation of (1), using macroscopical considerations for conductors satisfying Ohm's law, is based on the equipartition of energy.

Consider a conductor, the total charge of which is zero, with no applied external electric field. Though on the average the total charge is zero, the density of charge at any point in the conductor may fluctuate; an excess of negative charge at one point is counterbalanced by an excess of positive charge at some other point or points of the conductor. The 'equation of continuity', using the rationalized system of units, is:

$$\nabla . \vec{J} + \frac{\partial \rho}{\partial t} = 0, \qquad (2)$$

where $\vec{J}$ is the current density and ρ is the density of charge. For conductors satisfying Ohm's law, we have:

$$\vec{J} = \sigma . \vec{E}, \qquad (3)$$

where σ is the conductivity and $\vec{E}$ is the intensity of the electric field. Equation 2 becomes:

$$\nabla . \sigma \vec{E} + \frac{\partial \rho}{\partial t} = 0. \qquad (2a)$$

If the conductor is homogeneous and isotropic, then:

$$\nabla . \vec{E} = \frac{1}{\varepsilon} \rho, \qquad (4)$$

where

$$\varepsilon = \varepsilon_0 K_0 \qquad (5)$$

is the specific inductive capacity of the medium, ε_0 is relative to free space, and K_0 is the dielectric constant. Combining equations 2*a* and 4, we have:

$$\nabla \left(\frac{\partial \vec{E}}{\partial t} + \frac{\sigma}{\varepsilon} \vec{E} \right) = 0. \qquad (6)$$

We are interested only in the time dependence of $\vec{E}$, and as the conductor is homogeneous and isotropic, we take as solution of equation 6:

$$\frac{\partial \vec{E}}{\partial t} + \frac{\sigma}{\varepsilon} \vec{E} = 0, \qquad (7)$$

the integration constant being zero, since the applied external field is zero. (The final results are valid for a constant external field.)

Equation 7 is interpreted as follows: owing to the fluctuations of the density of charge, there results a fluctuating electric field. If at any instant the field is E_0, it will decay according to equation 7 with a time constant $\tau = \varepsilon/\sigma$, which is exceedingly small, namely, 2×10^{-10} sec. for sea water and 2×10^{-17} sec. for copper.

Using equation 7 to form the 'correlation function' $\overline{EE_t}$, one has[2] for $t > 0$:

$$\overline{EE_t} = \overline{E^2} . \exp\left(- \frac{\sigma}{\varepsilon} . t \right). \qquad (8)$$

The 'spectral component of intensity' for 'infinitely brief' correlations, that is, for frequencies $\nu << \frac{1}{2\pi\tau}$, we have

$$\overline{E_\nu^2} = 4\overline{E^2} \int_0^\infty \exp\left(- \frac{\sigma}{\varepsilon} . t \right) . dt = 4 . \frac{1}{\sigma} . \varepsilon \overline{E^2}. \qquad (9)$$

Assuming the conductor is cylindrical, of section s and length l, then

$$\overline{E_\nu^2} = \frac{4}{\sigma . s . l} . \varepsilon \overline{E^2} . s . l. \qquad (10)$$

$\varepsilon . \overline{E^2} . s . l$, in the system of units used, is the total mean energy of the electromagnetic field. Allowing $\frac{1}{2}kT$ per degree of freedom (the electric and the resulting magnetic fields) then:

$$\overline{E_\nu^2} = \frac{4}{\sigma . s . l} . kT. \qquad (11)$$

Finally, the mean-square E.M.F. of fluctuations per cycle, across the ends of the cylindrical conductor, is

$$\overline{e_\nu^2} = \overline{E_\nu^2} . l^2 = \frac{4l}{\sigma . s} . kT = 4R . k . T, \qquad (12)$$

where $R = \frac{l}{\sigma . s}$ is the resistance of the conductor

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Energy-Level Treatment of Reaction Data

IN a recent paper[1] it was shown that satisfactory explanations of certain aromatic side-chain reaction data are provided by correlation of the alterations in electron density which arise from the various electron displacements (inductive, inductomeric, mesomeric and electromeric) of the substituents with the energy-levels in the initial, transition and final states of the reaction. Such changes, relative to the energy-levels in the unsubstituted parent molecule as a reference standard, were represented by assigning arbitrary numerical values to each polar effect and thus obtaining a quasi-quantitative expression of their resultant effects on the activation energy of the reaction.

In the absence of data regarding the absolute magnitudes of the various polar effects such numerical values were, of necessity, somewhat arbitrary and in unknown units, although both in their signs and *relative* magnitudes, they satisfied the known order of electron release or attraction by the various mechanisms.

A recent paper by Audsley and Goss[2] has now provided reliable values for the primary (μ_P), induced (μ_I) and mesomeric (μ_M) dipole moments of the four monohalogenobenzenes. This data should provide at least approximately *quantitative* values for the corresponding electron displacements in the reaction previously used as an illustration[1], namely, the Menschutkin reaction

$$p-X.C_6H_4.CH_2.Br+C_5H_5N \rightarrow X.C_6H_4.CH_2.\overset{+}{N}C_5H_5\}\overset{-}{Br}.$$

The only magnitudes which must still remain hypothetical are those (*a*) of the electromeric (+ *E*) effect and (*b*) of the reduction in the inductive (− *I*) effect, of the halogen substituent in the transition state. Changes in energy-levels due to permanent polarization effects will be proportional to some (unknown) constant multiplied by μ. Using the same values for the two unknowns as those previously employed, but substituting the values of $10^2 \mu$ (which give whole numbers of convenient magnitudes) for the various permanent polarizations, the following results are obtained:

RELATIVE ENERGY-LEVELS IN THE REACTION

$$p-X.C_6H_4.CH_2.Br+C_5H_5N \rightarrow X.C_6H_4.CH_2.\overset{+}{N}C_5H_5\}\overset{-}{Br}$$

	Reduction in energy-levels in the ground state				Reduction in energy-levels in the transition-state					$E_g - E_a$
X	μ_P	μ_I	μ_M	Total (Eg.)	μ_P	μ_I	μ_M	E	Total (Eg)	
H	—	—	—	—	—	—	—	—	—	Reference standard
Cl	−184	−75	+95	−164	−184	−74	+95	+2	−161	−3
Br	−172	−70	+74	−168	−172	−69	+74	+4	−163	−5
F	−176	−72	+104	−144	−176	−65	+104	~0	−137	−7
I	−156	−64	+51	−169	−156	−63	+51	+7	−161	−8

It will be seen that the new values predict exactly he same order for the velocities of the various -halogenobenzyl bromides as that previously indiated, namely, activation energies decreasing in the order H > Cl > Br > F ≈ I, in agreement with the xperimental velocity sequence I ≈ F > Br > Cl > H. This agreement, using magnitudes which have a definite physical basis, strongly supports the essential correctness of the whole method of energy level treatment of reaction data and also suggests that the numerical values assigned to the electromeric effects probably give an approximate estimate of the *relative* magnitudes of these effects for the halogen group of substituents.

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Agricultural Research Institutes and the Future

DR. B. A. KEEN's article in NATURE of September 5, p. 282, does well to invite the attention of research workers to the possible future developments in agricultural education and research in Great Britain. It may be regretted that Dr. Keen sought to restrict his remarks to arable agriculture. I venture to hope, with Sir George Stapledon, that our future agriculture will be ley farming, and that most of our farmland will cease to be classifiable into the rigid categories of 'grass' and 'arable'. This, however, is a minor point.

Dr. Keen's suggestion for co-ordinated field experimentation may be warmly welcomed, and I would stress the importance of ensuring that research localities be carefully chosen to cover the principal classes of soil. Too often in the past, expensive and well-planned field experiments have been laid down without reference to soil type. Unfortunately, the national soil survey has not been in progress long enough for even a preliminary soil map to be made; but a considerable amount of information is available, and it would not be difficult to examine the suitability of proposed experimental areas in order to avoid the selection of non-typical sites.

Finally, although co-ordination of post-war agricultural research is inevitable, it may be hoped that the organization will not be too rigid. If a compromise is necessary between a system of complete freedom for the individual investigator and a totalitarian research system, let us err on the side of freedom even at the risk of a certain amount of overlapping.

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RESEARCH ITEMS

Insect Fauna of Lower California

THE peninsula of Lower California has an interesting insect fauna that has been long neglected by students. The terrain is possibly largely accountable, owing to the difficulties of collecting in such a desert region with its barely passable roads. It is consequently understandable that most insect collecting has been made in the Cape Region, which can be easily reached by boat. The California Academy of Sciences has been the leader in the biological exploration of Lower California but unfortunately its collections, made between 1888 and 1894, were largely destroyed in the great San Francisco earthquake and fire. Realizing the need for further collecting, Messrs. A. E. Michelbacher and E. S. Ross spent two months on the Peninsula in 1938 and the collections obtained seemed sufficiently large to make desirable the publication of a series of entomological reports in the *Proceedings of the California Academy of Sciences*. Of these reports six have already been published during 1942 up to June 20 and deal with an introductory account, the Cerambycidæ, Buprestidæ, Myrmelionidæ, Symphyla and Culicidæ. The authors are (respectively) A. E. Michelbacher and E. S. Ross, E. Gordon Linsley, E. C. Van Dyke, A. E. Michelbacher and T. H. G. Aitken. Several new species have been brought to light, particularly among the Cerambycidæ where they number 22 species out of a total of 116 species collected. From among the 58 species of Buprestidæ recorded eight are new and a similar number of new Myrmelionidæ are recorded.

Parasites of Shisham Defoliators in the Punjab

Indian Forest Records (N.S. Entomology, 7; 1942) contains a contribution entitled "On the Biology of the Parasites of the Shisham Defoliators in the Punjab Plantations" by R. N. Mathur with a note by C. F. C. Beeson. It appears that the defoliation of the shisham trees (*Dalbergia sissoo*) in the irrigated plantations presents several features of unusual ecological interest. The principal defoliators are caterpillars of the Noctuid moth, *Plecoptera reflexa* Guen., which, in turn, are attacked by 18 species of primary parasites. Defoliation by this insect, and certain other species, is epidemic annually because stands of poor-quality shisham on unsuitable sites form permanent foci of infection. Furthermore, stands of shisham that have not tapped the moisture-level in the deep subsoil come into leaf late. Also, shallow, frequent irrigation causes the defoliated trees to produce new foliage at a periodicity that conforms to the sequence of generations of *Plecoptera reflexa*. Defoliation can be controlled by restricting shisham to areas suitable for it and stocking unsuitable sites with other species. It is important to ensure that the taproots of shisham cuttings reach the subsoil moisture level in one or two seasons by means of deep controlled irrigation. Control of natural enemies follows automatically when stands are established under the foregoing principles. It is clear that the parasite population-density will be maintained at a higher level under improved conditions of shisham cultivation. Until such an improved environment is attained it is of little use attempting to introduce non-indigenous parasites as aids in the control of defoliators.

Mouth-parts of a Weevil (*Calandra granaria*)

DR. R. DENNELL has given an account of the above subject together with the rostrum and fore-intestine (*Phil. Trans. Roy. Soc.*, **231**, 247; 1942). It is probable that many of his deductions will apply to numerous other weevils of similar behaviour. It appears that the mandibles are asymmetrical and possess a markedly oblique axis of rotation and by this means the action of the teeth becomes determined. The so-called pharyngeal bracons reach their highest degree of development in Calandra and its allies, where they form long slender rods that extend freely almost the whole length of the pharynx. They are attached to the mandible of their side and are wrapped around the tendon of the adductor muscle. The working of the molar teeth of the mandibles in an antero-posterior direction causes the pharyngeal bracons, that are attached closely behind them, to move to and fro in the pharynx. It is by the frequent repetition of these movements that the bracons are responsible for the progressive transport of the food along the pharynx. A median tract of spines in the pharyngeal roof, it may be added, co-operates in the backward passage of the food. The paper is fully illustrated and provides the first connected account of the functions of the bracons just alluded to.

Histology of Mammalian Hair

THE importance of fibre histology in forensic science was pointed out, and processes involved in the identification of animal hair outlined by J. L. Stoves in a paper read to the Society of Public Analysts and other Analytical Chemists on October 7. Photomicrographs were shown to be of value for reference purposes and also as a means of presenting evidence in court. A description was given of new methods employed for the preparation of photomicrographs of (*a*) transverse sections, (*b*) longitudinal sections, (*c*) cuticular scale impressions. New features of apparatus were illustrated, and a number of photomicrographs shown demonstrating the histological features of various mammalian fibres.

Biochemistry and Genetics

E. L. Tatum and G. W. Beadle (*Proc. Nat. Acad. Sci.*, **28**, 235; 1942) have utilized their X-ray mutant of *Neurospora crassa* to study the synthesis of *p*-amino-benzoic acid. The mutant strain is unable to synthesize the vitamin. When supplied with this vitamin the mutant strain grows at the same rate as normal and reacts like the normal strain when sulphanilamide is given to the medium. The mutant differs from the normal strain by a single gene unlinked with sex and situated far from the centromere. The gene is concerned with the synthesis of *p*-amino-benzoic acid and presumably influences a single synthetic process. It is concluded from tests with related substances that the bio-synthesis does not involve the introduction of an amino group into a preformed benzene ring.

Genetics and Eye-movement

THE act of reading involves ocular shifts and pause at each line of print. These can be recorded by instruments, and it is found that the pattern of the eye movement is remarkably individualistic. By studying the eye-movement of twins H. E. Jones and D. H. Morgan (*J. Hered.*, **33**, 167–72; 1942) show that in addition to the habit differences in reading induced by training there are inherited differences. Identical twins often show as close a similarity in eye-movement pattern as between two records of one individual, whereas classroom mates who have been trained alike and who are similar in reading ability show marked differences in specific aspects of eye-movement.

Salivary Gland Chromosomes in Mosquitoes

EILEEN SUTTON (*Proc. Nat. Acad. Sci.*, 28, 268; 1942) shows that salivary gland type chromosomes may be found in the Malphigian tubes of *Culex pipiens* and *Ædes ægypti*. There do not appear to be heterochromatic regions as in Drosophila but the banded regions could be mapped quite well. There is a well-marked nucleolus in *C. pipiens* but in *Ædes ægypti* it is only observed in early stages. The banding of the chromosomes is not present in the earlier stages, but the nucleic acid is accumulated in globules, after which the nucleic acid would appear to be redistributed to form the banded structure. It will be remembered that drastic treatment with Kodani's process gives the reverse effect—concentration of the nucleic acid from the banded parts into globules.

Synthesis of Vitamins by Intestinal Bacteria

P. R. Burkholder and I. McVeigh (*Proc. Nat. Acad. Sci.*, 28, 285; 1942) demonstrate that several bacteria normally living in the intestines of higher animals synthesize biotin, riboflavin, thiamin, and nicotinic acid when grown in media free from these vitamins. The bacteria studied were *Eschericia coli, Proteus vulgaris, Bacterium aerogenes, Alkaligenes fecatis, Bacillus mesentericus* and *B. vulgaris*. *P. vulgaris* appeared unable to synthesize nicotinic acid and *B. mesentericus* is deficient in biotin. The amount of vitamin produced at 36° C. was greater than required by the bacteria; it was found that 1–15 per cent of the biotin and nicotinic acid present in forty-eight hour cultures may occur outside the bacteria. The greatest synthesis of vitamins would appear to occur during the first fourteen hours of growth.

Micro-determination of Calcium in Serum

THE procedure of Clark and Collip, which is widely used in clinical laboratories for the micro-determinaion of calcium in serum, is admittedly subject to a number of errors but was so designed that they should ancel one another. P. F. Holt and H. J. Callow, in paper read to the Society of Public Analysts and ther Analytical Chemists on October 7, find that such cancellation of errors does in fact occur provided the Clark-Collip procedure is strictly adhered to and the calcium content of the serum is normal. They describe a micro-procedure in which the errors are eliminated and which has the advantages of ease of manipulation, reduction in time of operation and applicability to smaller volumes of serum.

Preparation and Analysis for Iron of Hæmin and Hæmoglobin

AFTER a short reference to the problem of standardizing estimations of hæmoglobin in blood, G. E. Delory, in a paper read to the Society of Public Analysts and other Analytical Chemists on October 7, described procedures for the preparation of, and estimation of iron in, hæmoglobin and hæmin. Two analytical methods were described. In one the sample is incinerated after being moistened with nitric acid, the ash is dissolved in hydrochloric acid and the iron titrated with titanous chloride solution. The other, based on the colorimetric method of R. W. Thorp, depends on measurement of the colour produced by the reduced iron with $\alpha\alpha'$-dipyridyl. A photo-electric colorimeter particularly suitable for the method was exhibited by Dr. E. J. King.

Synthesis of Cellobiose

ALTHOUGH a synthesis of cellobiose was achieved by Freudenberg and Nagai in 1933 the yield was poor and there still remained the problem of obtaining a structurally definitive synthesis of the disaccharide. W. T. Haskins, R. M. Hann and C. S. Hudson (*J. Amer. Chem. Soc.*, 64, 1289; 1942) have now prepared synthetic epi-cellobiose octa-acetate from products derived from D-mannose and D-glucose (both synthesized by Emil Fischer), and converted it into cellobial hexa-acetate, which on oxidation with perbenzoic acid gave chiefly cellobiose hexa-acetate; this product on acetylation gave a 63 per cent yield of a crystalline mixture of α- and β-cellobiose octa-acetates, from which crystalline cellobiose was obtained in quantitative yield by deacetylation. The overall yield was 35 per cent.

'Heavy' Adrenaline

DEUTERIUM (heavy hydrogen) has been used as an indicator in biological experiments with the assumption that the substitution for protium (light hydrogen) causes no change in physiological action, and this is probably correct, although Erlenmeyr and Lobeck in 1937 reported that acetylcholine bromide in which the acetyl hydrogens were replaced by deuterium became slightly less active. G. R. Clemo and G. A. Swan (*J. Chem. Soc.*, 395; 1942) have prepared 'heavy' *dl*-adrenaline from 'heavy' catechol of approximate formula $C_6HD_5O_2$ and chlorodideuteroacetic deuteracid, forming 'heavy' chloroacetocatechol, which with a solution of trideuteromethyldideuteramine in deuterium oxide gave 'heavy' *dl*-adrenaline containing 90 atoms per cent of D. Physiological tests showed an elevation of blood pressure almost indistinguishable from that produced by a similar amount of 'light' *dl*-adrenaline, the replacement of protium by deuterium in this case producing little (if any) change in the physiological action.

Long-chain Acids containing a Quaternary Carbon Atom

BRANCHED-CHAIN fatty acids are scarce in natural products and those known are mostly related to terpenes. Oils of Hydnocarpus and related species, naphthenic acids from petroleum and fatty acids isolated from *Mycobacterium Lepræ* and *M. tuberculosis* (formerly regarded as toxins) are examples. A. J. Birch and Sir R. Robinson (*J. Chem. Soc.*, 488; 1942), who review previous work in the field, now describe the preparation of several acids containing a quaternary carbon atom, namely, trisubstituted acetic and propionic acids. The surface film behaviour of the substances and biological tests are only briefly reported. The synthetic methods, however, are fully described. Special attention was paid to the use of $\alpha\alpha$-dialkylsuccinic and $\beta\beta$-dialkylglutaric acids as intermediates, and also to the application of the Michael reaction to appropriate $\alpha\beta$-unsaturated ketones. Some acids prepared were 2 : 2-dimethyl-lauric acid, 2 : 2-dimethylstearic acid, 1-methyl-1-*n*-octyldecoic acid, 3 : 3-dimethyl-tetradecoic acid, 5-keto-3 : 3-dimethyl-lauric acid and 2-phenacyl-2-methyl-lauric acid.

EARTHQUAKES IN NEW ZEALAND

A VERY important review of New Zealand earthquakes by Dr. J. Henderson, director of the Geological Survey of New Zealand, and Mr. R. C. Hayes, acting-director of the Dominion Observatory, Wellington, New Zealand, has been issued*. Compared with other countries in which earthquakes are common, the frequency of earthquakes in New Zealand is relatively high. This is due to the occurrence of a large number of semi-destructive earthquakes and comparatively few major destructive earthquakes. During the years 1835–1934, there were 69 New Zealand earthquakes, of which 6 reached intensity 10 on the Rossi-Forel scale, 14 attained intensity 9 on the same scale, and the remainder were of smaller intensity. During the twenty years from 1921 until 1940 inclusive there has been an average of approximately 260 earthquakes felt in the islands each year, the average maximum intensity of the greatest shocks being rather more than 8 (semi-destructive) on the Rossi-Forel scale. During the year 1922 there were 1,187 earthquakes felt, but this abnormally large number was due to the Taupo earthquake swarm. The aftershocks of the Buller earthquake of June 17, 1929, also caused the total numbers in 1929 and 1930 to be greater than normal.

New Zealand may be divided roughly into four seismic regions:

(1) All areas of the North Island east and south of an approximate line from the vicinity of Whakatane in the Bay of Plenty to the vicinity of Hawera in South Taranaki, and all areas of the South Island north of an approximate line from the vicinity of Hokitika on the west coast, through the region of Lake Coleridge, to Banks Peninsula. During the years 1921–40 this region had an average of 97·8 earthquakes per year, 4·1 per decade of which were semi-destructive, and 1·7 per decade destructive (R.F. 9–10).

(2) South Auckland, western Bay of Plenty, Waikato, and Taranaki (except the southern portion). During the years 1921–40 there was an average of 23 earthquakes per year, of which 1·1 per decade were of intensity R.F. 8 (minor destructive) and there was none of greater intensity. The activity in this region tends to increase gradually towards the east and south, where it merges into region 1.

(3) Areas of the South Island, south of the boundary of region 1. In this region between 1921 and 1940 there were 12·1 earthquakes per year, of which 0·1 per decade were semi-destructive (R.F. 8), and none of greater intensity. Only one semi-destructive shock has been definitely recorded in this region (near Mount Cook), though early history suggests that heavy shocks occurred in the West Coast Sounds region in the years 1792, 1810, 1826–27. The eastern side is definitely less seismic than the western.

(4) Areas north of Auckland. In this region during the years 1921–1940 there was an average of 1·1 earthquakes per year, of which none reached intensity 8 on the Rossi-Forel scale. No destructive shocks have been known to occur in this region.

It is emphasized that these regions are approximate and that one region merges into its neighbours. Taken in conjunction with the geology of New Zealand, the above facts are most instructive, and apart from the geology they can scarcely be comprehended. Earthquake and volcanic activity are manifestations of the adjustments constantly occurring in the earth's crust. Around the great sunken area of the Pacific there is a more or less continuous belt of geologically recent mountains, and this belt as a whole is subject to "chronic and acute seismicity". Earthquakes sometimes happen within the belt itself, though a large proportion have their epicentral areas on its submerged frontal slope. Dr. Henderson states that the South Island of New Zealand and the eastern part of the North Island are on the crest of the great mountain ridge or crustal fold which forms a portion of the real border of the Pacific. This ridge maintains a relatively straight course north-north-east for 1,600 miles across the floor of the Pacific, nearly to Samoa. The Auckland Peninsula, part of a decidedly weaker fold, meets the main fold nearly at right angles in the Rotorua-Taupo volcanic region. The earthquakes of this seismically sensitive district, though they may be locally severe, are not usually felt far from their points of origin. On the other hand, the tectonic earthquakes that occur along the main earth-fold shake large areas, some of them being recorded on instruments throughout the world. These are caused by slipping of earth-blocks against their neighbours along fractures.

Many great fault-zones have been traced for long distances, but a few only have been active since European occupation. The Hawke's Bay earthquake of 1931 raised an area 60 miles long and in parts 10 miles wide in a north-east direction. The uplift was greatest along the south-east edge of the area, for miles amounting to 6 ft. or more. Numerous levels on the Heretaunga Plain and along the railway north of Napier showed that the uplift decreased north-westward, so that the area was slightly tilted in that direction. The ground east of the uplifted area sank, and parts of the Napier and Wairoa flats are more than a foot lower than before the earthquake.

In 1929, movement along a north-trending fault seven miles west of Murchison raised the ground east of the fault by about 15 ft., and caused it to shift north-west by about 9 ft. The uplift gradually decreased eastward and died out sixteen miles from the fault, facts indicating a slight tilt of the earth-block towards the east. Subsequent levellings showed that the block was sinking somewhat irregularly, a movement, no doubt, which caused some of the innumerable local after-shocks felt in the area over many months after the main shock.

Other sensible earth-movements occurred in connexion with the Taupo earthquake series of 1922 the Amuri earthquake of 1888, the Wellington earthquake of 1855, and probably the Awatere earthquake of 1848. There is also definite evidence of geologically recent differential movement of earth-blocks at several widely separated points in both Islands. Seismographs situated at Wellington, Auckland, Christchurch, Arapuni and New Plymouth registered four strong distant earthquakes during July 1942 (Provisional Bulletin, No. P 125). These were on July 7 8, 25 and 29. Additionally there were nineteen sensible shocks in the islands, none being greate than intensity 4 on the Rossi-Forel scale. Th greatest of these was on July 26 and was felt with intensity 4 (R.F.) in the western areas of North Island and the northern parts of the South Island.

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* "Earthquakes in New Zealand". Dominion Observatory, Wellington, W.1, New Zealand. Bulletin No. S. 63, extracted from the "New Zealand Official Year-Book, 1942".

SOCIAL BIOLOGY IN EDUCATION

A CONFERENCE on the place of social biology in education was held by the British Social Hygiene Council at Tavistock House, London, W.C.1, on October 24.

Sir Cyril Norwood, giving the presidential address, made no claim to be a biologist, but stated that during his forty years of educational work he had been increasingly impressed by the importance of biology in education. One of the implications of social biology is that sex education should be regarded as a normal part of the school curriculum. Sir Cyril made some chastening remarks about those who see the solution in the making of biology a compulsory subject in the School Certificate, remarking that he has a list of at least fourteen subjects which could make a similar claim. Further, deploring the fact of the ridiculously high standards of the university scholarships examinations and referring to the method of selection of sixth-form biologists, he emphasized that primary school pupils, being by far the most numerous, constitute the most important aspect of the problem. New advance after the War will inevitably be a matter of decades, particularly in view of the fact that a hundred thousand extra teachers will have to be found and trained. In this connexion the universities will have to face up to their responsibility in the training of teachers, especially by the provision of general honours courses, including biology and social science with a biological basis.

Later in the morning Mr. W. L. Sumner spoke on "Social Biology Now and in the Future". Referring to the annual decline taking place in the mean national intelligence quotient, he mentioned the need for considering eugenic measures. He pointed out that biologists to-day have sufficient knowledge to enable them to produce a biscuit containing adequate vitamins and minerals to satisfy daily needs, but in this as in other respects it is the economic application of biological knowledge that is faulty. In subsequent discussion Mr. David Jordan pointed out the need for democracy in the functioning of the school. Miss Taylor emphasized the importance of habit formation n the primary school, followed by a well-integrated general science course in post-primary schools. Other speakers referred to the results of the application of biological knowledge in the U.S.S.R. and the need for providing the people of Great Britain with an deal for which they will feel enthusiasm.

The afternoon session was opened by an address by Sir John Graham-Kerr. He gave an account of he life among the South American Indians of the Gran Chaco. He sketched their system of education, including education through the years of adolescence in preparation for adult life. The alertness which is he constant condition of primitive man contrasts very markedly with the unthinking automatism of he product of modern education. He pointed out hat the mere indiscriminate collection of facts is no more science than the heaping up of bricks is architecture, and stressed the importance of intermingling poetry and imagination with the accurate establishment of fact. The muscular performance of a skilled craftsman is just as much a manifestation of 'brain power' as is the production of the most erudite thesis. He deprecated the common tendency to regard manual work as in some way inferior to mental.

Mrs. E. J. Hatfield opened a discussion on "Social Biology for Teachers in Training", by stating that German university students in Munich and Nuremberg before the War of 1914–18 had no critical faculty whatsoever, and that she does not know of any educational system better than the English. In making plans for post-war training of teachers much thought must be given to the majority of the profession, namely, those who were trained many years ago. This would involve refresher courses lasting for at least a term, with full salary during attendance, in addition to the shorter refresher courses at frequent intervals. It has been her impression while lecturing that a training college student has, in general, a far greater social sense than the academic graduate teacher in the secondary school. The subject of hygiene in the training college, which is compulsory for all students, should include the fundamentals of biology together with its social implications, and in the universities there should be a social biology course for all graduates who intend to take up teaching.

In the discussion which followed, Miss Warden confessed an inability to understand exactly what is meant by the phrase 'social biology', but made a plea for greater co-operation between the medical and teaching professions, particularly in the provision of specialist knowledge on medicine to teachers and on education to medical people. Later in the afternoon Mr. C. Bibby mentioned that in January the Central Council for Health Education would be publishing the first number of a quarterly journal, *Health Education*, to meet precisely this need.

The evening session on "Our Responsibility for Human Quality in the Colonial Empire" was opened by Sir Francis Fremantle, giving population statistics from various countries. He quoted various conditional forecasts of population trends and mentioned that the real cause of the decline in the birth-rate is the decay of moral authority of parents, teachers and religion together with the fundamental economic conditions of acquisitive society. The Maoris were given as an example of recovery after apparently inevitable extinction, and the depopulation of Melanesia as a warning of what can happen when white men interfere with native methods of life.

PLANKTON OF THE NORTH SEA*

PHYTOPLANKTON of the North Sea is being investigated very thoroughly by examination of the continuous plankton records collected by the Oceanographical Department in the University of Hull. Earlier results were published in the Department's *Bulletin* in 1940 (for the years 1932–37), and the Diatoms for 1938–39, corresponding to the present part, in 1941. The distribution of the Dinoflagellates and Phæocystis in general provides further evidence of the points made in the preceding diatom paper. A picture has gradually been growing of the distribution of the phytoplankton in the area investigated, at first only in the north, later in the central and southern North Sea. Six extra steamship lines were run monthly: from Hull to Oslo, from Leith to Hamburg, Copenhagen and Lerwick, and from Pentland Firth to Hamburg and Bergen. In addition, records were obtained from the Faeroe Shetland Channel in 1939, the route crossing the southern entrance to the Faeroe–Shetland Channel and stopping some hundred miles past the Faeroe Bank. It is most unfortunate that all these valuable activities have necessarily been stopped by the War.

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* Phytoplankton of the North Sea, 1938–39. Part II—Dinoflagellates, Phæocystis, etc., by C. E. Lucas. The Faeroe-Shetland Channel, 1939, by C. E. Lucas, N. B. Marshall and C. B. Rees. *Hull Bulletins of Marine Ecology*, edited by A. C. Hardy and C. E. Lucas, Nos. 9 and 10, 2, pp. 47–94. Plates XXXIX–LXII. April, 1942. 8s.

This later dinoflagellate work differs from the previous reports in dealing to a certain extent with the separate species of Ceratium. *Ceratium fusus* is the most important of these, is usually much the most numerous and tends to determine the apparent distribution of the genus. At times it forms almost 'pure' communities. Increase in Dinoflagellates always follows that of the Diatoms. Phæocystis is usually abundant when there are fewer Diatoms and Dinoflagellates. The importance of 'patchiness' in all three groups is emphasized and also the rapid numerical change in relatively short time and space intervals. In the southern area between 1932–37 and 1938–39 it is found that after increasing until 1937 or 1938, the Diatoms and Dinoflagellates were much scarcer in 1938 and/or 1939, but Phæocystis was scarcer from 1934 until 1937 and increased again during 1938–39. On the whole, the flagellate data provide confirmatory evidence for the cycle of changes since 1932 which were first deduced from the diatom record up to 1937 and 1939, and have already received some confirmation from the zooplankton for the earlier period.

The persistence of the two large areas of dinoflagellate production in the north-west and south-east provides even better evidence than in the Diatoms of the general agreement between the adjacent and intersecting recorder lines.

It is very interesting that there are signs of relationship between the distribution of some of the Dinoflagellates in the north-western area and that of *Sagitta elegans elegans*, and this seems to point to a possible association between the organisms found in this area and the Atlantic influence that may be extended there. The north-western area corresponds broadly with Russell's (1939) area of "*elegans* water" and the south-eastern to his area of "coastal water". The distribution shown of the Ceratium species together with the Diatoms may possibly be associated with signs of an increased flow of (possibly phosphate scarce) water into the area from the English Channel after the early months of 1938. More evidence is provided suggesting that the phytoplankton-productive water of the preceding years may have moved out of the area in a northerly or north-easterly direction.

The results of the Faeroe-Shetland Channel line are very suggestive but much more data are required to bring the work into line with the rest. They do, however, provide for the first time a series of continuous records at fairly short intervals from spring to midsummer, and form a basis for future work.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Saturday, November 7

BIOCHEMICAL SOCIETY (in the Department of Organic Chemistry, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 11 a.m.: Discussion on "The Theory and Application of Chromatographic Methods to Biological Problems".

Saturday–Sunday, November 7–8

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at the Royal Society, Burlington House, Piccadilly, London, W.1).

Saturday

At 11 a.m.: Annual General Meeting. At 12 noon: Sir Richard Gregory, Bart, F.R.S.: "International Systems and Standards".

Sunday

At 10.30 a.m.: Symposium on Microfilm.

Monday, November 9

FARMERS' CLUB (at the Royal Empire Society, Craven Street, London, W.C.2), at 2.30 p.m.—Dr. H. I. Moore: "The Cropping Problem of To-day".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Capt. R. C. Farrow: "Forecasting Run-off from Snow Surfaces".

Tuesday, November 10

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Sir James Jeans, O.M., F.R.S.: "Evolution in Astronomy", 2.*

ASSOCIATION OF SCIENTIFIC WORKERS (at the Royal Photographic Society, 16 Princes Gate, South Kensington, London, S.W.7), at 6.30 p.m.—Projection of the Cine Films entered for the Exhibition of "Photography in Science and Industry".

Wednesday, November 11

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. A. W. Ashby: "Agriculture To-day and To-morrow", 1: "Efficiency and Output in Agricultural Systems".

Thursday, November 12

INSTITUTE OF FUEL (at the Connaught Rooms, Great Queen Street London, W.C.2), at 2.30 p.m.—Dr. G. E. Foxwell: "The Provision of Smokeless Fuel for Post-War Reconstruction".

PHARMACEUTICAL SOCIETY (at Friends House, Euston Road, London N.W.1), at 2.30 p.m.—Prof. J. C. Drummond: "Nutrition".

Friday, November 13

ASSOCIATION OF SCIENTIFIC WORKERS (at the Royal Photographic Society, 16 Princes Gate, South Kensington, London, S.W.7), a 6.30 p.m.—Dr. H. Mandiwall: "Technical Cinematography in Colour"

Saturday, November 14

GEOLOGISTS' ASSOCIATION (at the Geological Society, Burlingto House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. C. E. N. Bromehead: "The Early History of Water Supply".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on o before the dates mentioned:

TEACHER OF GENERAL SCIENCE SUBJECTS, and a TEACHER O ENGINEERING SUBJECTS—The Principal, Luton Technical College Luton, Beds. (November 12).

SPEECH THERAPIST TO THE ISLE OF ELY COUNTY COUNCIL EDUCATION COMMITTEE—The School Medical Officer, County Hall, March Cambs. (November 12).

LECTURER IN CHEMISTRY AT THE HULL MUNICIPAL TECHNICA COLLEGE, CHIEFLY FOR INORGANIC CHEMISTRY—The Director c Education, Guildhall, Hull (November 16).

HEADMASTER OF THE GUILDFORD JUNIOR TECHNICAL SCHOOL—The Chief Education Officer, County Hall, Kingston-upon-Thame (November 17).

BIOCHEMIST FOR RESEARCH WORK OF NATIONAL IMPORTANCE I THE DEPARTMENT OF PHYSIOLOGY AND BIOCHEMISTRY—The Secretary National Institute for Research in Dairying, Shinfield, Reading.

LECTURER-IN-CHARGE OF CHEMISTRY—The Principal, Handswort Technical College, Golds Hill Road, Handsworth, Birmingham 21.

LECTURER ON WORKS ORGANIZATION AND MANAGEMENT—Th Principal, West Ham Municipal College, Romford Road, Stratfor London, E.15.

ASSISTANT MASTER TO TEACH SCIENCE AND MATHEMATICS IN TH JUNIOR TECHNICAL SCHOOL FOR THE BUILDING INDUSTRY—Th Director of Education, Education Office, South Parade, Nottingham

TWO INSTRUCTORS FOR DAY CLASSES FOR TRAINING OF MARIN ENGINEERS, at the Stow College, School of Engineering—The Directo of Education, 129 Bath Street, Glasgow, C.2 (November 20).

GRADUATE WITH GOOD HONOURS DEGREE, FOR STATISTICAL RESEARCH—The Secretary, Rothamsted Experimental Station, Ha penden, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Catalogues

A Catalogue of Books and Periodicals on Astronomy, Chemistry Electricity, Engineering, Mathematics, Mining, Navigation, Physic etc. (No. 603.) Pp. 32. (London: Bernard Quaritch, Ltd.)

Catalogue of Lewis's Medical and Scientific Lending Library, Suppl ment 1938–1941. Pp. 168. (London: H. K. Lewis and Co., Ltd 4*s*. net (to Subscribers, 2*s*. net).

Old Science and Medicine, Early Photography. (Catalogue 68 Pp. 49. (London: E. P. Goldschmidt and Co., Ltd.)

Cambridge Polarograph (Heyrovsky Pattern) for Micro-Analysi (List No. 109.) Pp. 36. (London: Cambridge Instrument Co., Ltd

Radiology: the Library of a leading British authority on t subject of Radiology, Röntgenology and kindred Sciences. Pp. 1 (London: The Museum Book Store, Ltd.)

Easy-Flo Silver Brazing Alloy. (Publication 122.) Pp. 4. (London Johnson, Matthey and Co., Ltd.)

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SOCIAL SECURITY AND SOCIAL SERVICES

THE interdepartmental Committee on Social Insurance and Allied Services under Sir William Beveridge's chairmanship, set up to survey the existing schemes of social insurance and allied services, including workmen's compensation, and to make recommendations, the report of which is expected shortly, is dealing with a problem that closely concerns one of the great purposes of the nations now fighting for freedom and for a civilization based on respect for human personality. The idea of social security springs from the deep desire of men to free themselves from the fear of want. To realize this idea the causes of insecurity must be removed wherever possible, and the individual assured of that protection against the common risks of life which he cannot provide by his own unaided efforts.

The fact that the dangers and uncertainties of war stimulate many of the highest virtues of individual men and women should not lead us to underrate the great significance of freedom from want. When insecurity lasts for years and becomes part of a nation's life, its effects are just as deadening as those of unbroken security. For the last twenty-five years more than half the population of Great Britain has lived on the knife-edge between poverty and destitution, and the fear of falling into one or the other has stultified initiative and led to a desperate saving for the future at the expense of the present. Various stop-gap social services relieved, but did not cure, poverty and unemployment. We are at last coming to realize that the survival of democracy after the War depends on the replacement of unemployment by full employment and the reconciliation of security with freedom.

It is a significant sign of the times that recognition that the achievement of social security depends both on social and economic planning and on the willing acceptance by a free community of the sacrifices and restrictions involved is becoming more widespread. It is elaborated in a notable broadsheet, "Planning for Social Security", issued earlier in the year by Political and Economic Planning (P E P), which is based on a memorandum submitted to the Beveridge Committee. It is also implicit in one of the latest Studies and Reports of the International Labour Office, "Approaches to Social Security: An International Survey". This latter report does not merely round off the long series of studies of the International Labour Office on social insurance and assistance by reviewing the contributions to social security of these modes of bearing social risks. It is also intended to prepare the way for planning a complete social security programme in readiness for post-war reconstruction.

The resolution on aims and functions of social insurance, adopted at Havana in December 1939 by the Second Labour Conference of the American States which are members of the International Labour Organisation, shows the extent to which the social security ideal had taken shape in the minds of

American Governments before President Roosevelt's famous Four Freedoms speech or the Atlantic Charter. The resolution is appended to "Approaches to Social Security", the whole forming an admirable survey of the essentials by which the proposals of the Beveridge Committee will in due course be judged. The essay is a statement complementary to the P E P broadsheet, which is limited to a discussion of British practice and to British proposals, the merits of which are the more clearly seen against this background of general tendencies and experience.

A brief survey of social insurance shows clearly that responsibility for meeting social needs has been dispersed among numerous agencies, without much regard for plan or order, and the illustrations given in the third chapter of "Approaches to Social Security", on co-ordination of social assistance and insurance into a coherent system of social security, indicate the measure of what remains to be done to establish a system affording reasonable security for all who need it. Moreover, it must be recognized that security is a state of mind as well as an objective fact. To enjoy security there must be confidence that the benefits will be available when required, and to afford security, the protection must be adequate in quality and quantity.

Elimination of the causes of social insecurity consolidates and improves the structure of society, but social security policy can only be planned as part of a larger programme which includes measures for promoting employment and maintaining it at a high level, for improving nutrition and housing, multiplying facilities for medical care and widening opportunities for general and vocational education. Social security services are promoted by economic adjustments that make for the expansion of employment and for the distribution of income so as to procure the essentials of decent living, with due consideration for family charges. Such adjustments facilitate the financing of social security schemes, not only tending to keep benefit expenditure within bounds, but also to reduce it, since improved conditions of life and labour reduce the frequency and severity of social and industrial risks.

Compared with this survey, the P E P broadsheet is much more forthright and critical. Its major interest lies, however, in the constructive proposals advanced in regard to principles of reconstruction and a Ministry of Social Security. It puts forward a provisional scheme for a process of reconstruction which might extend over the next thirty years. It is an examination of basic principles and an attempt to define the objectives of long-term reconstruction, but it does not discuss secondary or immediate issues.

Besides the establishment of a national Plimsoll line of goods and services, the State must assume the wider duty of planning the use of our economic resources and man-power for full employment and maximum welfare. The building of post-war social security, moreover, will depend on acceptance by the citizen of stronger obligations and new compulsions. The opportunities and responsibilities which enhance the freedom of every citizen by making his rights real can only be enjoyed when the price is paid o accepting expert advice and skilled services to find work, to be trained or transferred for work, and to keep fit or to be speedily restored to health and independence. If we can get away from the futility o pressing a man to train for a job which does not exist; or of putting a sick man on to an inadequate allowance and driving him back prematurely into industrial conditions which can only undermine his health again, and remove some of the administrative absurdities and complexities, we shall have little cause to fear that the development of a social security system will sap the morale and independence even of the nation's least responsible elements.

The first essential, according to *Planning*, is therefore the establishment of a Ministry of Social Security to take over, among other things, administration o all income-maintenance services.

In regard to detailed services, the broadsheet suggests the unification of the medical services by divorcing them financially and administratively from National Health Insurance and from public assistance and organizing them in one national system which provides its services to all citizens as a right. To extend the scope of the National Health Insurance scheme to include persons of "like economic status" and the dependants of all insured persons, and to afford a far wider range of skilled services, as suggested by the National Conference of Friendly Societies, ar regarded as likely to impede rather than promote the unification of health and medical services into a comprehensive national system. It is a cumbersome approximate to the ultimate solution visualized by the Royal Commission of 1926 of "a carefully built up service organized on a single local basis in which all varieties of preventive and curative work find thei appropriate place".

The advantages of a system in which all medical services are provided on the basis of commo citizenship to every member of the community ar detailed, and the idea of the health centre and o co-operation and team-work among doctors and close contact with specialists, with the benefit to the genera level of medical work, are well set forth in the broadsheet. Similar points were stressed by the Dawso report of 1920 and developed in the recent report o the Medical Planning Commission of the British Medical Association, as well as in the report o National Health Services written by Dr. Jane Campbell for the British Association for Labour Legislation. While the local health centre may provide ne opportunities for active citizenship on a neighbourhood basis, a reconstructed income-maintenance system can clearly hold no place for administratio of incapacity cash benefits by approved societie That system must disappear, since the only approve society required is the nation itself.

Naturally enough, the broadsheet does not go int the detail of the recent report of the British Medical Association's Committee on Industrial Health i Factories, but it recognizes the contribution whic such a Board through its industrial medical servic might make towards extending first-aid services an raising their quality—a field in which air-raid pr cautions should not be without effect—as well as in passing on research problems to the Industrial Health Research Board. Any step which tends to stimulate industrial health research indeed merits careful examination, and among the further suggestions of *Planning* are, first, the development of an adequate system of first-class centres and departments for traumatic surgery, and, secondly, the creation of a proper system of special centres for diagnosis and treatment of occupational diseases and for research into their causes and conditioning factors. Here the British Medical Association's Committee on Industrial Health in Factories has rightly stressed the importance of co-operation between the medical profession, scientific workers, the factory inspectorate, employers, social workers, and the workers and their organizations. Finally, the Board should be responsible for vocational training schemes as well as entrusted with the care of all physically handicapped persons who might be rendered fit to engage in a remunerative occupation, and it should maintain a specialized service for placing disabled workers. The whole network of services involved in medical rehabilitation is so intimately bound up with other medical services, including hospitals, that they should be provided and controlled by the same authorities which are responsible for all the major medical services, although the Board should have powers of supervision and inspection of facilities.

This valuable broadsheet makes it unmistakably plain that any real unification and reconstruction of the social services in Great Britain will involve an immense amount of educational work to ensure the full co-operation, not merely of the numerous societies and local authorities concerned, but also of the individual citizens. It is the more welcome, therefore, that such a document should have appeared in advance of the Beveridge report, and that attention should also be directed to a scarcely less ambitious project in the Americas. The conference which met at Santiago de Chile affords evidence that in America also resources are being pooled in a positive effort to realize the common ideals of freedom from want and fear. A committee has already been constituted for the systematic and continuous exchange of information among the social security institutions of the American countries, and has set as its goal the establishment in each country of compulsory social insurance, covering industrial accidents and occupational disease, sickness, maternity, old age, invalidism, premature death, and involuntary unemployment, and applying to self-employed peasants and domestic servants as well as to industrial and commercial workers.

The case for a comprehensive and well-planned system in Great Britain could scarcely be better put than in the P E P broadsheet, and that such widespread attention should be given to this question of social security is a hopeful sign. It should not be forgotten that domestic policies, by promoting full employment and purchasing power, have a most favourable reaction on those difficult problems which will be encountered in the reconstruction of world trade after the War. Already the U.S. National Resources Development Board, in its report for 1942 now before Congress, demonstrates that planning for social security finds an accepted place in the post-war plans of the United States. While it is reasonable that the Government should decide to await the Beveridge report before taking any action in regard to social services, there will be grave disappointment if there is delay in implementing a real social security policy and programme based on the recommendations of that report. Failure to do so would be a blow both to the immediate war effort and at the post-war aims and association of the United Nations.

THE CASE FOR PASTEURIZATION

The Pasteurization of Milk

By Prof. G. S. Wilson. Pp. xii+212. (London: Edward Arnold and Co., 1942.) 18*s*. net.

THIS is a well-planned, well-written and well-documented book, but with a title that may, to some, give a slightly wrong impression of its contents. It concerns itself almost entirely with one main theme—a reasoned statement of the medical evidence in favour of the pasteurization, or effective heat treatment, of all milk. The bacteriological, particularly the public health aspects of pasteurization, as might be expected from Prof. Wilson, are treated with care and thoroughness, and a balanced summary is given of the relevant nutritional findings of the past ten or fifteen years. It is, however, no manual for the pasteurization engineer or technologist—that book has still to be written—and the economic, legislative and administrative aspects of milk processing also are only very briefly touched on.

How it came to be written is explained by Sir Wilson Jameson in a foreword. The Milk Industry Bill, one of the few really constructive legislative efforts of the decade before the War, was introduced in November 1938 and, by what many consider a grave error of judgment, was withdrawn after its first reading. Among a number of other measures the Bill gave local authorities permissive powers, subject to certain limitations, to make pasteurization compulsory in their areas. After its withdrawal, representations were made to the Ministers of Health and Agriculture in the hope that further legislative endeavours would be made to rescue the safety of the milk supply of Great Britain from the wreckage of the Bill. Though these representations were unsuccessful, they convinced the then Minister of Health, Mr. Walter Elliott, that there was need for the further education of opinion on the whole subject of pasteurization of milk in relation to public health. He asked Prof. Wilson to bring existing evidence together and review it, and this book, publication of which was considerably delayed by the outbreak of war, is the result.

As propaganda—and that in no sinister sense—it is successful and convincing. People who wish to retain anti-pasteurization beliefs as part of their religion are strongly advised not to read it. If they do they can scarcely avoid being persuaded of two things: first the need, from the point of view of national health, for efficient heat treatment of all commercial milk before it is consumed by human beings, and second, that pasteurization carried out by modern methods does not "rob milk of its essential elements" but has in truth a negligible effect on the milk's nutritive value.

One cannot help wondering, nevertheless, whether the book is not, now, knocking at a door already ajar. Even before the War the tumult and the shouting over pasteurization were dying, and the War itself has enabled a proper perspective to be achieved the more readily. The basis for the high emotional potential at which the pasteurization controversy, at its climax some fifteen years ago, was conducted was partly scientific, but to a much greater extent economic. The scientific world had, not very long before, been awakened to the essential part played by vitamins, particularly in the nutrition of the young, and to the fact that some of these factors were thermo-labile. Cow's milk was evidently one of their most important sources. Was not pasteurization, therefore, likely to diminish seriously the nutritive value of this vital food ? Was the alleged risk of disease and death—surely not a very serious one since very many drank raw milk but few seemed to suffer as a consequence—to be compared with the apparent certainty of loss of invaluable food factors as a result of heat treatment ?

Prof. Wilson collates and appraises existing data, and shows how serious is the first risk. His sombre statements as regards the extent of milk-borne disease cannot be far from the truth. As regards nutritive value, it has been clearly shown during the last seven or eight years that the effect of pasteurization on the vitamin content of milk, and on its nutritive value generally, is negligible. Prof. Wilson marshalls his evidence here very cogently, but quotes the several careful experiments begun about 1935 at the instance of the Milk Nutrition Committee (under the chairmanship of Lord Astor) on the feeding of comparable quantities of raw and pasteurized milk to children, to calves and to rats, as if they were just a number of sporadic and isolated investigations, whereas they were a planned and co-ordinated series which was designed to solve and, in fact, did solve, the question as to whether the commercial pasteurization of milk had any serious effect on the nutritive value of that milk.

A serious fear of those who opposed pasteurization so strenuously in the twenties and early thirties was that compulsory pasteurization—and none of us in peace-time likes anything compulsory—would increase the stranglehold of the large distributors on the producers of milk and would drive the producer-retailers out of business. There might have been some reason for this fear in the days before the advent of the Milk Marketing Board. Since that advent in 1935, the organized distributors have had to deal with an organization no less formidable than their own, and the economic argument against pasteurization has become far less intense. Nevertheless it is unlikely to disappear while producer-retailers exist who cannot pasteurize their milk before distribution. In such cases, is there to be a place for tuberculin-tested raw milk ? This question is at present of increasing quantitative importance, as the gallonage of milk retailed by producer-retailers has greatly increased since 1939.

The producer-retailer's case may be met after the War by the increased manufacture of small 'batch' pasteurizers that were being developed in the thirties to deal efficiently with fifty gallons of milk or even less. With the perfection of these plants—associated with a policy of partnership among the smaller producer-retailers to establish units of a reasonable economic size—the objective of the pasteurization of *all* milk for liquid consumption in Great Britain will be within technical range. Prof. Wilson says, "the need for pasteurization is fully justified by all the available scientific evidence and is supported by such a wealth of authoritative medical opinion as has seldom before been united in favour of any measure. . . ." He might without distortion have added "dairy scientific opinion", which has to consider, in addition to the medical aspects, other bearings of the pasteurization question.

H. D. Kay.

PSYCHOLOGY AND RELIGION

Psychology and Religious Truth

By Dr. Thomas Hywel Hughes. Pp. 160. (London : George Allen and Unwin, Ltd., 1942.) 7*s*. 6*d*. net.

In these lectures Dr. Hughes deals with some of the estimates of religion formed by psychologists. Freud's view that religion originates in the sex instinct is rejected by Dr. Hughes on the ground that this instinct is not itself fundamental but derivative from the will to live, which he regards as being the source of religion. He includes under this instinct not only the impulse to keep alive but also the wish to live well, for he takes the view that a spiritual no less than a biological need expresses itself in the will to live. Especially is this the case when a self-conscious stage has been reached. Also, religion arises from and gives expression to the whole personality and not just to a part, for example, the sexual. The view associated with the names of Durkheim and Levy Bruhl, that religion originated in the herd instinct, is also rejected. According to Levy Bruhl, the conception of God is in reality nothing but the idea of society or social cohesion, as it finds its unity in strong emotion. The decisive objection to this theory, in Dr. Hughes's opinion, is the fact that religion is an intensely individual and personal matter, and however far back we go, we find that religion begins in single souls who initiate the social movements in religion.

Some psychologists, of whom Leuba and Freud are examples, have taken the view that the idea of God is an illusion due to two familiar mental processes, projection and regression. The human mind projects and personalizes its own private feelings and desires, and often gives its projections content and meaning by clothing them in a garb of early memories and experiences. But Dr. Hughes points out that this process of mental projection is not necessarily a form of self-deception. Some of the principles upon which all our scientific knowledge is based are such projections ; for example, the principle of the unity and uniformity of Nature. Nature itself as it appears to the observer is far from being a unity, but the scientific inquirer projects into Nature his own consciousness of personal unity. Just as he is himself the integrating bond which links into one whole all his diverse experiences, so he projects upon the diversity of Nature a similar principle of unity. It by no means follows that such a procedure is illegitimate ; on the contrary, it has proved highly fruitful in results, and has enabled Nature to be reduced to order and understood. A similar projection is the idea of causation, which projects on to Nature man's consciousness of initiating action. From the mere observation of Nature only a succession of events is discernible, as Hume pointed out ; the idea of causation is a projection of the human mind, which is justified by results.

Dr. Hughes also examines Leuba's estimate of religious experience as of like nature with the experiences resulting from drugs, alcohol, or some pathological state. That some mystical states are subjective and induced by drugs or other similar means does not warrant the conclusion that all mystical states are illusory. One might argue that the illusory nature of the snakes observed with so much distinctness by the sufferer from delirium tremens proves that all snakes are illusory. Moreover, the effects of genuine religious experience are very different from those induced by opium or gin; they strengthen and enrich the character, bestowing upon the individual the capacity to endure the heaviest strains, mental, moral and physical. The prophetic utterance, "And a little one shall become a thousand", has come true often enough in the history of religion, which can release hidden potentialities to a surprising extent.

In opposition to the Behaviourists, Dr. Hughes is confident that "a psychology with a soul" is now in the ascendant, "perhaps more so than at any time since the beginning of modern philosophy in Descartes". He holds that this is largely due to the psycho-analytic school, who have put the *psyche* with its moods and energies at the centre of their teaching. One of the great gains to psychology from the new psychology, in his view, has been that it has rid the study of the predominantly material and physiological bias so long associated with it. He observes that the problem of the relationship between body and mind is by no means settled; he does not refer to Sir Charles Sherrington's recent pronouncement as to the impossibility of reducing mind to terms of energy. But he expresses the opinion that "the trend of psychological thought is towards regarding the idea of a future life as at least probable".

Dr. Hughes also has interesting chapters on the bearings of psychology upon certain specific Christian doctrines, such as the Trinity, the Atonement, and the Person of Christ. The discussion of the doctrine of the Atonement will perhaps be of most interest to psychologists, as facts of human nature are primarily concerned. Dr. Hughes observes that Freud "has revived the conception of original sin, and even afforded some support to the idea of total depravity". Another point is the distinction drawn by modern psychology between sin and moral disease, which has made it easier to deal with certain weaknesses of character. On the other hand, it is important to realize that sin is always a matter of the will and implies personal responsibility. The notion of moral disease may easily be led to 'cover a multitude of sins' to the doubtful advantage of the patient. We could wish that while dealing with this topic Dr. Hughes could have devoted some space to an examination and evaluation of the Pauline psychology of 'spirit' and 'flesh' which is certainly out of date, and which gravely affects the efficiency of the attempts of the Christian church to give guidance on certain moral problems. One feels that if one is to equate the 'flesh' with the 'libido', it must be the source of much that is of value as well as of some things less attractive. But perhaps Dr. Hughes will deal with this and other similarly interesting questions, among which we should include the body-mind problem, in another series of lectures. Meanwhile he deserves our thanks for a very useful piece of work.

J. C. HARDWICK.

BIOCHEMISTRY—GENERAL AND PARTICULAR

Annual Review of Biochemistry

James Murray Luck, Editor; James H. C. Smith, Associate Editor. Vol. 11. Pp. ix+736. (Stanford University P.O., Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1942.) 5 dollars.

HERE we have a volume of more than 700 pages with scarcely a mention of war; there has been little diminution in the scientific production of the free peoples. It is indeed refreshing to escape into such an oasis of progress, away from the constant repetition of war news and war aims which assails us on the air and in every form of printed literature—newspaper, journal and novel.

The editor reminds us that these reviews now enter their second decade, and that they started in a period when great scientific activity was independent of severe economic depression. What a lot they have had to chronicle, what a storehouse of information for him minded to produce a book on a decade of progress! We had begun to write that the sciences covered by the elastic term biochemistry had surpassed all others in the rate of advance when we remembered that in physics the same applies.

The world to-day is largely science-conscious; the spread of education and the provision of educational facilities have borne fruit. The trained men are there, keen in their generation; the spores of new conceptions are found in the atmosphere of any college. New methods of experimentation make for quicker results, easy publication brings them quickly to the cynosure of the critical. Each step forward by one opens up the way to new advances by many. There is no prostitution of science to evil ends, for surely the man of science is free to defend his freedom with all likely weapons at hand. It is as noble to discover something of use to humanity, to alleviate sickness as to investigate something of no use to anybody. It is true that one never knows when the purely theoretical may turn up trumps, as when Lord Rayleigh's weighing of nitrogen led to the discovery of the rare gases; but this did not become less meritorious because it led to such an advance in electric lighting.

The answer is plain: let the scientific man go his own way, following his inclinations to understand and to discover; endeavour shall be his watchword. Let there be more laboratory facilities, more scholarships, more books; then the world will glean the kindly fruits of science.

There are twenty-six topics this time in the "Annual Review of Biochemistry", with many new names among the authors. The treatment varies according to the suitability of the subject for review; that is, whether it can be summarized to definite conclusions.

An interesting section is that on lignin, by Harold Hibbert, who has done so much for cellulose chemistry at McGill. The molecule is a complex one and is now held to contain propylphenol units, the union being of a carbon to carbon type involving oxygen ring formation between side chains and aromatic nuclei. The mechanism of the synthesis of phenols in the plant is also discussed: these are apparently synthesized in both the lower and higher forms of plant-life to function as hydrogen transportation, respiratory catalysts. In the higher plants, such catalysts eventually undergo a complex series of changes to yield lignins.

The sterols are much to the fore; one review by C. W. Shopper, of Leeds, summarizes recent work on the steroid sapogenins, the cardiac glycosides and the toad poisons; another on hormones, by J. J. Pfiffner and O. Kamm, of Detroit, emphasizes in particular that relationship of structure to physiological action which is a perennial field of inquiry by chemists.

Biochemistry is advancing from the general to the particular. For example, W. D. Armstrong devotes twenty pages to the teeth under the heading of constitution and properties of dental tissues; Selig Hecht, in thirty pages, describes the chemistry of visual substances, largely the visual purple, regarded as a conjugated protein.

A reviewer can do no more than cite a few headings, avoiding the temptation to dwell on those subjects which have most appeal to him; there comes the reflection, if we only had time to read and try to master the whole. For this is what our medical advisers have to do in the future, though by then it will be presented in potted and tablet form for easy assimilation. One thing is certain, in ten years time there will be as much as ever to discover, even though all we know to-day will then appear as but the foundations of knowledge. Yet some compounds still refuse to give up their secrets: sugar, for example, has not yet been made in the laboratory.

E. F. ARMSTRONG.

SOCIOLOGY AS AN ACADEMIC DISCIPLINE

An Introduction to Sociology

By Prof. John Lewis Gillin and Prof. John Philip Gillin. Pp. viii+806. (New York: The Macmillan Company, 1942.) 18*s*. net.

SOCIOLOGY is achieving maturity as a discipline. Its increased recognition in American as distinct from most British universities is indicated by the appearance of university text-books. Whether as a subject it is in any way distinguishable from political science is a reasonable matter of doubt, depending upon whether we understand politics as Aristotle did or as something to do with politicians.

Messrs. Gillin and Gillin omit to note that the State is a modern phenomenon and that political science can scarcely be, and in fact is not, limited to study of it. They do not discriminate here between scientific and popular usage. Aristotle knew nothing like the modern State and begins with discussion of the family. It is not an issue discussed in the present volume. This overlooking of studies in political science, in the traditional acceptation of that word, deprives the book of some of the interest which it might possess, and could with advantage be remedied in a later edition.

Here we have a straightforward text-book of highly commendable lucidity, comprising chapters on population, culture, kinship groups, political constitutions, religious constitutions, social change, delinquency and crime. Some of the 'exercises' appended to the chapters raise interesting questions in the minds of those of us who recall that, for example, Prof. Laski holds (to my mind wrongly) that history and the social sciences cannot be 'objective'. For example, one 'exercise' reads: "What biases would you have to beware of if you set out to study scientifically fascism? Democracy?" What biases, one wonders, would Profs. Gillin have to beware of? Or Mr. Bernard Shaw? Or the professors of the Marx-Lenin Institute, Moscow?

Owing to the vast field covered, accuracy rather than novelty is aimed at, and the chief significance of this book, for any reader who is not a class student, is that it shows what is the shape increasingly being assumed by this subject in the ordinary teaching curriculum of two distinguished universities. It provides an admirable 'orientation' and general background for more specific studies. Discussions of methodology are reduced to one chapter. But the student who asks for an adventure of ideas in social questions will here find stimulus, and the student perplexed by issues of 'race theory', moral evolution, economic security and the like will be given perspective. As such a guide this manual will doubtless perform a very useful purpose.

GEORGE CATLIN.

PSYCHOLOGY OF WAR AND PEACE

War and the Psychological Conditions of Peace

By Dr. William Brown. A second and enlarged edition of the author's "War and Peace". Pp. viii+144. (London: Adam and Charles Black, Ltd., 1942.) 7*s*. 6*d*. net.

DR. WM. BROWN'S volume "War and Peace: Essays in Psychological Analysis" appeared in 1939, and now re-appears in a new edition with a new title. Three new chapters are added, the size of the book being thus increased by about a half. As the earlier chapters were written before the outbreak of war, and the later ones since that event, the reader has an interesting opportunity of seeing how well the author's estimate of the Nazi psychology has been borne out during the last three years. Dr. Brown's qualifications for writing such a book are unique. He has known Germany from his student days, and has kept his knowledge well up to date ever since; he is eminent in the fields of experimental psychology and psychiatry; he gained close knowledge of the psychology of the fighting man in the War of 1914–18 during his four years of active service; and he has taken the utmost pains to understand the mysterious Hitler and his hold upon the German people.

Steering clear of propaganda, and speaking only as a psychologist, Dr. Brown regards Hitler as cunning and clever, but "held firmly in the grip of his paranoid nature". To say that Hitler is only a figurehead is to under-estimate his importance as not only the creator but also the creation of his followers, whose nature is such that it dovetails into his. That there are plenty of Germans who will work for world-peace after the War Dr. Brown is convinced. Meantime the position is full of peril, and when Germany has been defeated and punished she will need re-education, in which process many highly cultured Germans of the older generation will take part honestly and thoroughly.

The general reader will find little difficulty in following the author's argument, but it may be suggested that he will do well to make some preliminary study of paranoia and paranoid tendencies in one of the best treatises on abnormal psychology. Dr. Brown's note at the end of his fifth chapter will be found helpful.

RUTHERFORD: LIFE AND WORK TO THE YEAR 1919

By PROF. H. R. ROBINSON, F.R.S.*
Queen Mary College (University of London)

"I AM sure that we all ought to . . . give some of our recollections of those past and gone before they are lost for good."

These words, written by Rutherford himself in a letter to Rayleigh (March 1936), may well serve as my text. There are in existence excellent biographies of Rutherford, as well as obituary notices in many scientific and other journals; it will therefore be unnecessary for me to attempt to give a connected account of the first forty-eight years of Rutherford's life. I shall try to mention the more salient facts, though I shall necessarily be restricted to a bare minimum of detail, but I want above all to convey, so far as I can, some impression of the atmosphere of proud and contented endeavour and achievement which he maintained in his laboratories in Manchester. I do not under-estimate the difficulty of this; Rutherford has filled so much of my mental horizon ever since I became his pupil in 1908, that I can scarcely expect to see everything concerning him in a perspective which others would necessarily recognize as true, but I will try to do it.

Fortunately, though Rutherford's genius was of a most uncommon kind, and his character and outlook difficult to assess, we have, in addition to personal recollections, one extremely valuable source of information; mainly through Lady Rutherford's care and forethought, a great part of Rutherford's correspondence has been preserved and filed. We have, therefore, expressed in Rutherford's clear and vigorous English, much first-hand information that would otherwise have been lost to us.

Rutherford's paternal grandfather, George Rutherford, a wheelwright, left Scotland in 1842 to settle, with his family, in New Zealand. His son James, born in 1839, married in 1866 Martha Thompson, who had come to New Zealand at the age of twelve, and who for a short time before her marriage worked as a school teacher. Ernest Rutherford, born on August 30, 1871, was the fourth of the twelve children born of this marriage. He was born at Brightwater (Spring Grove), not far from Nelson; four years later the family moved to Foxhill, and in 1882 to Havelock, both in the neighbourhood of Nelson. Ernest attended the State primary schools at Foxhill and Havelock, and apparently was very well taught at both schools. In 1886 he won a scholarship which took him to Nelson College, and at about the same time his family moved to Pungarehu, in North Island—not very far away—where his father, who had previously worked as a wheelwright, farmer, timber contractor and engineer, now concentrated on large-scale flax production.

Nelson College was evidently a model establishment, with an excellent headmaster in W. J. Ford and a fine mathematical master in Dr. W. S. Littlejohn, who gave Rutherford a sound start in mathematics and physics. Rutherford had a very successful three years in Nelson, winning awards not only in his best subject, mathematics, but also in Latin, French, English literature, history, physics and chemistry. It is on record that in June 1888 he was top of the sixth form in *all* subjects.

In 1889 he won a junior university scholarship which took him to Canterbury College, Christchurch, where he had again a continuous record of academic success. It was in Christchurch that he met, and became deeply attached to, Mary Newton, who became his wife in 1900.

Rutherford did his first research work—on the magnetization of iron in rapidly alternating fields—in a draughty cellar of Bickerton's laboratory at Christchurch, and later he developed an ingenious magnetic detector of electromagnetic waves. This work, which would have been remarkable enough as the first performance of a young researcher under the most favourable conditions, must rank even higher when we think of the circumstances in which it was done.

In 1895 the award of an 1851 Exhibition Science Scholarship enabled Rutherford to move to a great centre of research, and he elected to go to Cambridge—beating J. S. Townsend by a short head for the distinction of being the first research student to enrol under J. J. Thomson for the research degree newly instituted in Cambridge for workers from other universities. We find soon afterwards, in a letter to Mary Newton (October 3, 1895), "I am very glad I came to Cambridge. I admire Thomson quite as much as I thought I would, which is saying a good deal."

Here he continued work on Hertzian waves with his magnetic detector, and had notable successes in detecting waves at—for the time—great distances from their source. He soon, however (Easter 1896), dropped this to work with Thomson on the new subject of ions in gases, building up in a remarkably short time a very complete theory of gaseous conduction and determining experimentally many of the characteristic properties of the ions. From this work, by an entirely natural transition, he passed to the study of the recently discovered Becquerel rays, thereby finding his true life's work—radioactivity.

Here we may with advantage pause to recall the state of atomic physics at the time of Rutherford's first Cambridge period. It was one of almost unparalleled activity. In November 1895, Röntgen discovered X-rays, largely by accident. Becquerel's discovery of radioactivity in February 1896 was largely a second accident arising out of Röntgen's discovery. It was, of course, the use of X-ray tubes as sources of ionization that made possible Rutherford's work on gaseous conduction.

About the same time Lorentz, the great pioneer of electron theory, was able to show that the newly discovered Zeeman spectral effect could be quantitatively explained by the assumption that spectral lines were the result of radiation by charged particles the specific charge of which was of the order of a thousand times that of the hydrogen ion in electrolysis. The electron, possessing this property, was isolated by J. J. Thomson in 1897, and shown to be a constituent of all ordinary matter—and this may be taken as the starting point of the modern electrical theory of the atom. The charge of the electron was measured soon afterwards by Townsend, Thomson and others; another essential link in the chain of discovery was Townsend's brilliant work on the diffusion of gaseous ions, which proved beyond doubt that the charge of a normal gaseous ion was identical in magnitude with that of a monovalent electrolytic ion.

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* From the first Rutherford Memorial Lecture of the Physical Society, delivered on November 6.

To some extent, therefore, Rutherford's entry into radioactivity and atomic physics was an accident of time and place—but this is the last occasion on which we can speak of any element of chance in his life's work. From this time on, he made and pursued his own line, and it would scarcely be an exaggeration to say that his subsequent achievement would have been little less imposing or significant if, in the whole period with which we are concerned, he had been completely oblivious to everything that went on outside his own mind and his own laboratory.

In 1898, when in full career, Rutherford made the difficult decision to leave Cambridge for the Macdonald research professorship of physics at McGill University, Montreal. Rutherford's estimate of himself at this time (which was clearly much less high than that which Thomson had formed) is quaintly expressed in a letter to Mary Newton. "It sounds rather comic to myself", he says, "to have to supervise the research of other men, but I hope I will get along all right." To anyone with the least knowledge of Rutherford's career, it must seem more than "rather comic" that Rutherford should have harboured such doubts. Even much later still, with an immensely fruitful period behind him, he showed himself inordinately gratified that foreigners like Hahn and Godlewski should think it worth while to go over to Canada to work with him.

The outstanding advance made in the McGill period was the development of the disintegration theory of radioactivity, first advanced by Rutherford and Soddy in 1903. By the time Rutherford left Montreal for Manchester, in 1907, this theory had been established beyond all reasonable doubt, and many of the details of the sequence of transformations had been elucidated. Rutherford had fully established, in his own mind at least, the nature of the alpha particles and had made rough measurements of their velocities and specific charge. He had also measured, with Barnes, a number of heating effects. His fame was now securely established, and he made of his laboratory what its founder had always hoped it would become, a permanent centre of research in Montreal. Higher education in Canada owes much to Rutherford—an indebtedness which has been generously and repeatedly acknowledged. On his side, Rutherford was at least equally ready to point out that the benefits of his association with Canada were by no means one-sided.

Rutherford's invitation to Manchester was largely due to the foresight of Arthur Schuster, who had marked him down some time before as the successor he would wish to see in the Langworthy chair of physics. Schuster was, for a physicist, a wealthy man—a fact on which Rutherford commented naïvely in a letter to his mother soon after his arrival in Manchester. He was, moreover, like so many of his race, not only generous, but also generous with rare discrimination, and when he retired to make way for Rutherford, he endowed, out of his own pocket, a readership in mathematical physics—the one thing needed to complete the strength of the department. The Manchester laboratory was, for its time, well designed and equipped, and could produce adequate supplies of liquid air. It was less well fitted than McGill for radioactive research, but Rutherford was never a stickler for luxury in working materials, and Feather has recorded in his biography that on June 6, 1907—less than three weeks after leaving Montreal—he was setting up an emanation electroscope in his new laboratory.

He was lucky in the men he found in the Manchester laboratory, most of whom turned over to work in radioactivity. He was perhaps most fortunate in finding Hans Geiger, a young graduate of Erlangen who had already done research under Schuster, and William Kay, a young mechanic who soon afterwards became head steward of the laboratories. To Kay, who surely ranks high among the world's greatest laboratory stewards, must go the credit for much of the smooth running of the laboratory.

Geiger was a well-trained and capable all-round physicist, with a considerable command of experimental technique, and his enthusiastic collaboration proved invaluable to Rutherford from the outset. Rutherford and Geiger's electrical counting of alpha particles—an amazing technical feat in those days—was completed within a few months of Rutherford's arrival, and the paper was read before the Royal Society in June 1908, with that on the total charge carried by the particles.

An acute shortage of radioactive material in the laboratory, which faced Rutherford on his arrival, was soon relieved by a generous loan of 450 mgm. of radium bromide made to him by the Vienna Academy. Shortage of apparatus became rather serious as the work of the laboratory rapidly expanded, but no doubt Rutherford at this stage in his career had no difficulty in tapping a number of sources for research funds. Dr. Norman Smith, Registrar of the University of Manchester, has been kind enough to get for me the details of the annual grants made for apparatus and equipment to the Physics Department throughout Rutherford's tenure of the chair. For the pre-war years, these (excluding amounts earmarked for electrotechnics) averaged less than £420 a year, and in 1915–19 they dropped far below this figure. With these grants Rutherford worked wonders, and there can be few instances in the history of science of comparably rich yields from such modest investments.

Rutherford attracted to Manchester many experienced workers from other universities, and by now he had learnt to see nothing abnormal in this. He was so full of ideas for work that he needed every man he could get, and he trained as many as possible of his own students for research—it being quite usual for an undergraduate to begin on a selected problem in his third year at the University. Geiger, appointed research assistant, took over much of the training in radioactive measurements, and the training course was substantially that described in Makower and Geiger's "Practical Measurements in Radioactivity", published in 1912.

Rutherford's most fruitful contribution to general atomic physics arose directly out of the results of an experimental problem which had been given to Ernest Marsden, one of the first of the Manchester trainees. This was the work on large-angle α-particle scattering, carried out mainly by Geiger and Marsden in collaboration. As Rutherford put it many years later, "I told Geiger that young Marsden should begin a research. Why not let him see if any α-particles can be scattered through a large angle ? I did not believe that they would be. . . . It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15-inch shell at a piece of tissue-paper and it came back and hit you" ("Background to Modern Science" (1938)). Thus originated Rutherford's nuclear theory of the atom, which he worked out in masterly fashion in 1911, and which changed the whole face of modern physics. The picture of the atom was completed by Bohr who, after working for some months in Rutherford's laboratory, first applied new quantum principles to the electrons of the nuclear atom, and by Moseley's brilliant work on the X-ray spectra of the elements, begun in Manchester in 1913.

It was characteristic of Rutherford that, though his research school was almost completely dispersed by the War of 1914–18, and though his time was so fully taken up by work of national importance at home and abroad, he should have contrived during those years to carry through successfully yet another epoch-making research. In experiments which he began in 1917 and ended early in 1919, generally with Kay alone to help in setting up apparatus and counting scintillations, he succeeded in showing that the nitrogen nucleus could be disrupted by the impact of a swift α-particle, with the emission of a hydrogen nucleus. This, the first detected example of 'artificial transmutation', was the last work he published from Manchester; its further development belongs to the second Cambridge period.

When I, as a young student, first met Rutherford in 1908, he was at the height of his powers—as he had indeed been for many years and as he remained right to the end of his life. I am sorry that I was not one of that generation of students of whom Rutherford wrote to Boltwood in October 1907, that "I find the students here regard a full professor as little short of Lord God Almighty". I can, however, testify that this was how Rutherford was regarded by the men of my year and those who followed us, though he was mistaken in believing—if he really did believe—that all full professors were objects of reverence to their students.

Officially, honours students had no lectures from the professor in their first year, but in practice we used regularly to attend his elementary lectures, partly because they were really illuminating, whatever their topic, and partly for the beautiful, and often sensational, experiments which Kay prepared for them. It seemed at times that it was Kay's taste in lecture demonstrations that really dictated the course of a lecture, and sometimes—not often—Kay was called upon to act as prompter, in response to appeals in which Rutherford presumably believed that he had reduced his normally huge voice to a scarcely audible whisper.

We also at times saw Rutherford walking along the corridors, singing lustily a tune recognizable as a rendering of "Onward, Christian Soldiers", and later we knew this to be a sign that research was going particularly well. I was interested to learn many years later, from an article by Prof. Norman Shaw, that this, I believe quite unconscious, habit dated from the McGill period. In less favourable times there was a melancholy dirge which no one ever identified—partly because, for obvious reasons, it was considered tactful to let him have the corridor to himself on these occasions, which were fortunately very rare.

We saw Rutherford in his most inspiring form at the physics colloquium, which met on Friday afternoons, the meetings being preceded by an enormous tea-party at which Lady Rutherford generally presided. Rutherford always addressed the first meeting of the session, giving with obvious enjoyment a summary of the main work done in the laboratory during the preceding session. The attendances were large, as many of the chemists and mathematicians came over to hear Rutherford, and in the atmosphere of sustained enthusiasm which he created, no young student could fail to feel that he was highly privileged to be of that community. I think we all felt then that we were living very near the centre of the scientific universe, and maturer reflection has only served to convince me more strongly that we were right. This sense of privilege naturally grew stronger in those who went on to do research, even in those of us who were doing relatively humble tasks and not, like Moseley, the things that were going to matter fundamentally for years to come.

I should like to state some of the more obvious reasons for Rutherford's extraordinary power as a leader of research. First, of course, there was his own unique and apparently almost intuitive grasp of the essentials of a problem. Next, his interest in the course of an investigation and his impatience to know the result were so passionate that they inevitably infected even the laziest of his co-workers. Then there was his incorrigible friendliness to even the least worthy of his research men; a man who is invited regularly to Sunday supper at his professor's house, who meets him nearly every day across the laboratory tea-table, who is generally treated as the social equal of an emeritus professor, and who is constantly and pointedly asked how his work is getting on, is likely to do more and better work than one who is left to feel that nobody wants him or his results very much. No doubt Rutherford's friendliness was partly due to his upbringing in New Zealand, and enhanced by nine years of life in Canada; no one who has seen much of New Zealanders in the mass can have failed to recognize that they are an unusually friendly and companionable people. Rutherford had these qualities in an extraordinarily high degree, and they undoubtedly helped to keep things going in the laboratory.

I would emphasize, too, in this connexion Rutherford's obvious and enormous delight in experimentation. I remember once, after he and I had wasted the whole of a fine Saturday afternoon in a quite ineffectual attempt to purify a very dirty little sample of radon with which we had hoped to work, Rutherford's saying with obvious sincerity, as he sucked contentedly at his pipe, "Robinson, you know, I *am* sorry for the poor fellows that haven't got labs. to work in!" It is not really surprising that in such an atmosphere a man like Andrade, arriving fresh from work on ionization in flames and from the making of metallic single crystals, should have found himself in next to no time working on gamma-rays, or that Darwin, the second of the Schuster Readers, coming under contract as a mathematician, should have suddenly found himself involved with gold-leaf electroscopes and an experiment on a branching radioactive series.

This lecture began with a quotation from Rutherford. It may fittingly end with a quotation from von Helmholtz, part of an address given sixty years, almost to the day, before the death of Rutherford. Von Helmholtz was speaking of his own great teacher, Johannes Müller, and after referring to the student's need for "daily mental intercourse with teachers from whom he learns something of the workings of the thoughts of independent minds", he goes on to say, "Anyone who has once come in contact with one or more men of the first rank must have had his whole mental standard* altered for the rest of his life".

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* von Helmholtz, "On Academic Freedom in German Universities", 1877 (Atkinson's translation). The literal translation is "mental measuring-rod".

RECOVERY OF METALS FROM SCRAP*

By SIR HAROLD HARTLEY, C.B.E., F.R.S.

THE dominant feature of industrial development in the nineteenth century was the use of power, but closely associated with it and of scarcely less importance was the enormous increase in the use of metals made possible by metallurgical progress. In 1800, for example, the world production of iron and steel was about half a million tons; in 1900 it was forty million tons, and now is more than three times as great. This rapid growth in the use of metals made serious inroads into the world reserves of ores, and in some countries the available resources, particularly of the richest ores, were exhausted or seriously depleted; so that the problem of conservation has become urgent, and with this lies a close connexion with the question of the ultimate fate of metals in use and their recovery as scrap. To what extent are they lost in use? Do they, in fact, follow man-made cycles like the well-known carbon and nitrogen cycles in Nature, so that the world stock is not in fact depleted?

Unavoidable losses in the use of metals or alloys due to wear, corrosion, heat and dispersal dissipate them so that they cannot be recovered; similarly, their use in chemical compounds such as pigments tends as a rule to total loss. The only examples of metals in which there is little such wastage apart from their use in plating or in thin films are the so-called precious metals, gold, silver and the platinum group. An exact study of the fate of the industrial metals is impossible owing to the lack of accurate statistics and to the uncertainty as to their secondary uses, but it is clear that in this century scrap is playing an increasingly large part in metal production and must enter into any comprehensive survey of world metal supplies in the future.

In the United States, for example, it is estimated that in recent years (1929–38) ferrous scrap has amounted to 75 per cent of the output of steel, while non-ferrous scrap has accounted for 50, 45 and 35 per cent of the total domestic consumption in all forms of copper, lead and aluminium respectively.

Each metal presents a different problem according to its nature and uses, but there are certain general aspects to be considered first in order to clarify so far as possible a somewhat confused picture.

Definition of Scrap

The word 'scrap' is used here to cover what are often described as secondary, reclaimed or runaround metals. Obviously there are different types of scrap which may be defined to indicate their origin as:

1. *Process scrap.* Scrap arising in the production of a finished or semi-finished article which is re-used in the plants of origin. This includes ingot heads, gates and risers from castings, crop ends of rolled material, trimmings from sheets, tubes, etc., all of which are normally returned to the melting furnaces in the same works.

2. *Engineering scrap.* Scrap such as swarf, drillings, turnings and rejects produced in engineering shops which are usually separated from the primary production, so that this scrap cannot be so quickly absorbed. Further, its physical character and high degree of oxidation often make it difficult to use in re-melting furnaces.

3. *Old scrap.* This consists of disused material arising from obsolescence, accident and worn-out parts. Recovery of this is a skilled trade involving the breaking-up of machinery into its component scrap categories; for example, a motor-car is stated to contain no less than twenty-five different ferrous alloys and the same number of non-ferrous alloys.

It is, of course, impossible to make hard and fast distinctions between these three classes, particularly between 1 and 2, but these two classes cover new scrap, metal that has not been in service, as distinct from 3. Scrap of classes 2 and 3 may, however, easily get mixed in the process of collection before it reaches the producer again.

Disposal of Scrap

The disposal of scrap metals and their use to the best advantage is becoming more complicated each year owing to the increasing use of alloys. The whole problem would be vastly simpler if metals were used mainly in a pure state, or admixed in the case of iron with carbon alone. In many cases, for example bearing metals and tool steels, the alloys are kept separately in the process of collection for re-use after re-melting and adjustment of their composition, as the recovery of the constituent metals from their alloys would be a wasteful and often a difficult and uneconomical operation. The sorting and classification of scrap is therefore a matter of great importance. For process scrap it is an easy matter, as this goes straight back to its own melting furnace. For engineering scrap the segregation is relatively easy if it is properly organized in each works, but the scientific sorting of old scrap presents much greater difficulties and requires careful organization to avoid waste. The higher prices paid for special alloys is an incentive to make the sorting as effective as possible. However, this is not so easy with small admixtures of alloy metals, and increasing difficulties are arising from the presence of these in undesirable quantities in the recovered metal.

One of the main difficulties of getting a true statistical picture of scrap recovery is the extent to which certain scrap is re-used directly without coming into the market. This applies to all process scrap and to a certain amount of engineering scrap which is recovered directly; for example, brass turnings go back direct to the brass foundry. In large organizations there is also a considerable re-use of old scrap which would not appear in any statistics. For example, railway chairs go back to the foundry, which may use as much as 95 per cent of old scrap. Bearing metals are also recovered internally and re-melted with the necessary additions of virgin metals which alone appear in the statistics. Similarly, copper scrap must reach the brass foundry unaccounted for, as the amount of copper used in brass making is less than the equivalent amount of zinc which is known to be used for this purpose.

The picture is complicated further by the re-use of suitable old scrap for the direct manufacture of other articles. For example, the re-rolling of old rails to produce a variety of articles is carried out on a considerable but unrecorded scale, and locomotive axles can be forged down and heat treated for crank pins of smaller diameter, or used for many other purposes. Small bars of mild steel can be used for drop forgings. The re-fabrication of old scrap has been greatly helped in recent years by welding, and especially during the War has made considerable progress. Much of this re-use of scrap which makes a considerable contribution to the conservation of mineral resources does not appear in any statistical review.

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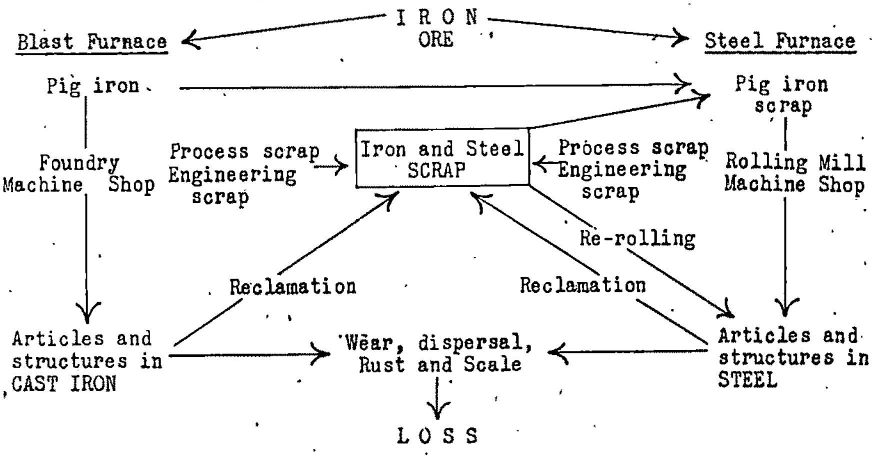
* Paper read on July 25 at the Conference on Mineral Resources and the Atlantic Charter, arranged by the Division for the Social and International Relations of Science of the British Association.

Relationship between Total Production and Scrap Recovery

The volume of consumption at any moment depends on new demands and on replacements due to obsolescence, corrosion and wear and tear. It is therefore clear that unless there should be heavy accumulations of scrap or new demands had vanished in a severe depression, the amount of scrap arising from replacements must always be less than the total amounts of metal required for current production. The relation between the two will vary with the metal metal and the circumstances.

With the modern tendency to rapid development and quicker obsolescence, the life-cycle of metals will in general be shortened. On the other hand, welding has made possible the repair of steel, for example at rail ends and in locomotive fire boxes, which will increase the service life of metals. The development of improved materials with increased hardness, greater resistance to wear and fatigue, and to corrosion (including painting and surface treatment) also tends to lengthen the life-cycle and eliminate losses of metal. The use of lighter designs, the increasing use of sheet metal and of a multiplicity of small 'gadgets' may, however, tend to make scrap recovery less complete.


IRON ORE
Blast Furnace
Steel Furnace
Pig iron
Pig iron scrap
Foundry Machine Shop
Process scrap Engineering scrap
Iron and Steel SCRAP
Process scrap Engineering scrap
Rolling Mill Machine Shop
Re-rolling
Reclamation
Reclamation
Articles and structures in CAST IRON
Wear, dispersal, Rust and Scale
Articles and structures in STEEL
LOSS

Life-cycle of iron

An interesting point arises in connexion with the increased use of reinforced concrete in place of steel construction. This effects a considerable saving of steel amounting to 50–60 per cent; but on the other hand it is not economical to recover much of the steel in reinforced concrete, whereas the bulk of a steel frame can be salvaged.

Relative Atmospheric Corrodibility of Metals

Metal	Friend (*J. Inst. Metals*, 42; 1929). 7 years in Birmingham City air. Loss of weight (%)	Hudson "Corrosion of Iron and Steel" (1940). Sheffield industrial atmosphere. Rate of corrosion (mils/year)
Mild steel	10·3	5·0
Wrought iron	6·7	3·8
Cast iron	3·5 (approx.)	Good resistance
Zinc	0·54	0·70
Nickel	0·47	0·41
70/30 Brass (2 Pb)	0·39	0·57
Copper	0·18	0·28
Aluminium	0·11	—
Tin	0·10	—
Lead (soft)	0·09	0·26
Stainless steel (12 Cr)	0·10	—
18 Cr 8 Ni	—	0·003

For iron and steel, corrosion is the biggest factor, which Speller estimates may lead to an annual replacement of two per cent of the total tonnage in use. For other metals the effect is much less, as is shown in the accompanying table giving the results of exposure of metals in the industrial atmospheres of Birmingham and Sheffield. The two sets of results are expressed differently, but the metals appear in the same order in each.

When all these variable factors are taken into account and the uncertain statistics as to the use of scrap, it is not surprising that it is impossible to draw up an exact balance sheet covering losses and recovery of any metal, as will be seen in the sections dealing with the separate metals.

Iron and Steel

At present iron and steel represent about 93 per cent of the total world tonnage of metal production, It has been estimated that of the total output, 15–20 per cent is lost from rusting, and that in all 35 per cent is lost irrecoverably due to rust, dispersal and the use of iron and steel in articles from which recovery is uneconomic. 65 per cent is left to find its way back into use, of which 25 per cent is process scrap which does not leave the steel works, and the remaining 40 per cent returns at a rate dependent on obsolescence, wear and the state of industrial activity. With improved protection against rusting, losses will be reduced, but quicker obsolescence will shorten the life-cycle.

The following figures for recent steel production in Great Britain confirm this estimate, remembering that some scrap goes to blast furnaces and that an addition must be made to the percentage of scrap in the table to allow for this:

Year	Total production	Pig used	Scrap used	Scrap (per cent)
1935	9·6	4·6	5·8	56
1936	11·8	5·6	6·9	55
1937	12·9	6·2	7·5	56

The recovery of ferrous scrap in the United States has reached a higher figure in recent years, averaging 75 per cent of the steel production, possibly due to quicker obsolescence.

The main difficulty which has arisen in the recovery of ferrous scrap is due to the increase in the number of alloys, which makes it increasingly difficult to segregate scrap of similar character. The result is that the amount of the residual elements tends to increase in ordinary steel, producing undesirable results. For example, the presence of nickel and chromium may produce a steel very different in characteristics from the steel required. Rejection has occurred from this cause, emphasizing the importance of improved methods for segregating most carefully scrap from alloy steels of various compositions, in order to utilize them most economically and to avoid the presence of elements which may upset the normal properties of the steel. The introduction of controlled grain size straight carbon steels often avoids the need for using alloy steels, and they have the additional advantage of simplifying the recovery of scrap, since they contain no other elements.

In the case of alloys with a high percentage of other elements, for example stainless steel or tool steels, the large differential in scrap price is an incentive to see that they are kept separate.

Manganese, Nickel and Chromium

There is only a small recovery of manganese in the form of high manganese alloys, as the bulk of it is used in steel manufacture as a deoxidizer and desulphurizer and is lost in the slag.

Only a small percentage of nickel is recovered, as much of it is lost in low-nickel steel alloys which go into ordinary scrap or in nickel plating. Undoubtedly more could be saved by the segregation of nickel alloys. Recovery is presumably better for the high-nickel alloys. In the United States scrap recovery has progressed steadily and in 1938 was about 2,000 tons.

Little is known about the recovery of chromium, except that its high price encourages recovery by producers and fabricators of the alloys and by large consumers. The expanding demands for chromium steels will make the segregation of chromium alloy scrap of increasing importance.

Copper

The United States statistics for copper recovery are more complete than for any other metal and so it is possible to give a clear picture of the position. Owing to its relative freedom from corrosion, wastage should be relatively small and its value is favourable for salvage.

Copper is recovered and passes into use again both as metal and as brass and other alloys, and it is important to distinguish between the two. United States statistics for 1929–38 show that, of the domestic consumption of copper metal, approximately 6½ million tons in those years, 2⅓ million tons, or 39 per cent, came from scrap recovery, of which roughly one third came from new scrap (process and engineering) and two thirds from old scrap. Scrap recovery in addition yielded nearly 2 million tons of copper in the form of brass or alloys. The total contribution of recovery, therefore, to the domestic use of copper in all forms was approximately 50 per cent for this period.

The trend of scrap recovery over a period of years shows a close relation to the index of industrial production. Increasing prosperity means new consumption and the quicker replacement of obsolescent articles. Increased production means increased new scrap, and the flow of old scrap depends on the rate of replacement. Apart from stocks this flow is, in fact, a direct function of current consumption. Hence it is not surprising that the volume of scrap recovery of copper should be related more closely to the index of production than to current scrap prices. The length of the life-cycle of copper will vary with the level of industrial activity.

Tin

About half the total tin production is used as pure metal for making tinplate and as foil for various purposes. The rest is used in various alloys, solder, bearing metal and bronzes. Tin is recovered from the clean tin scrap and from the dross arising in the course of manufacture of tinplate, but the recovery of tin from used cans is not in general economical owing to the difficulty of collecting and cleaning them. There is also a considerable recovery from tin alloys. United States statistics for 1929–3 show a recovery of metallic tin from scrap amounting to eight per cent of the total consumption as pure tin and alloy, and a recovery in the alloy form amounting to 26 per cent, so that on an average one third of the consumption was provided from the recovery of scrap. About 6 per cent of the tin is used in various chemical compounds and this is irrecoverable.

Lead

The major uses for lead are storage batteries, cable covering, sheet and pipe, and a small proportion is used in alloys. The processes of manufacture are relatively simple and they result in little process or engineering scrap. Owing to the relatively large percentage of lead used in pigments, in ammunition and as tetra-ethyl lead in motor spirit, and the loss of bearing metals by wear, there is inevitably a considerable irrecoverable loss. On the other hand, the recovery from storage batteries probably amounts to 80 per cent after an average cycle of two or three years in motor-vehicles, while the cable covering is also largely recovered after a longer period of years.

United States statistics for 1929–39 show that the recovery of lead as metal produced 1,349,000 tons, one third of the total production of refined lead during that period, and that, in addition, 1,017,000 tons were recovered in the form of alloys, thus saving an equal quantity of virgin metal.

Zinc

A large proportion (probably 40 per cent) of zinc production is used for galvanizing iron to protect it against corrosion, and none of this is recovered, the zinc being sacrificed for the protection of the so-called iron, but which to-day is mild steel. However, there is a wastage of some 20 per cent of zinc in the galvanizing pot, much of which is recovered as dross, which is re-distilled for spelter or zinc dust. The next largest use of zinc is for brass-making, a considerable proportion of which is recovered and re-used. Apart from this, there is only a small recovery of zinc from the articles in which it appears in the rolled form. The United States statistics show that the recovery of zinc as metal has averaged 11 per cent of metal production, and in addition slightly less has been recovered in the form of alloys. A considerable loss occurs each year from the use of zinc in pigments.

Aluminium

There is a considerable scrap recovery of aluminium and aluminium alloys. Process scrap is usually remelted in the works when it is produced. Engineering scrap (turnings, millings, filings, etc.), which may amount to 50–200 per cent of the weight of the finished article, requires special methods of melting to ensure both a good yield and quality and is usually returned to specialist firms, the secondary metal melters. The segregation and cleaning of the various types of scrap are of great importance.

Old scrap presents a more difficult problem, as it has to be separated into the different alloys, a skilled job requiring experience and the use of scientific methods.

United States statistics for 1929–38 show that out of a total production of one million tons of metal, one fifth came from scrap recovery. In addition, about 225,000 tons of aluminium were recovered in the form of various alloys, making the total contribution of scrap to consumption in this period about 35 per cent.

Export of Scrap

Nothing has been said yet about the export of scrap, but to secure maximum recovery there should be a flow back to metal-producing from non-producing countries. The statistics for iron and steel scrap, which are fairly complete, do show this in a few cases, such as Holland and Switzerland, but the bulk of the transfer of scrap, which averaged 5 million tons a year for 1933–38, actually took place between steel-making countries, owing largely to preparations for war. Under happier auspices the International Scrap Convention, established in 1937, might have done much to avoid this uneconomical transfer.

Conclusion

The absence of world statistics on the recovery of scrap makes it impossible to give a comprehensive picture of its full significance. However, it is clear from the data given above that scrap recovery will be of increasing importance as regards the conservation of our metal resources, and that as a major source of raw materials it must be brought into any general scheme affecting them under the Atlantic Charter.

Taking conservation first, the following measures would help towards a maximum scrap recovery and help to diminish wastage of metals : (1) The salvage of all new and as much old scrap as possible. (2) Improved methods for segregating engineering scrap of different kinds so as to avoid mixing different metals and alloys. (3) Improved methods for sorting and cleaning old scrap and identifying doubtful material by quick tests. (4) Improved methods for cleaning scrap and putting it into a suitable form for remelting. (5) Arrangements to avoid losses by corrosion when scrap, often finely divided, is kept for long periods. (6) Avoidance of the unnecessary use of alloys, which complicates scrap recovery, and the reduction of the number of alloy specifications to the minimum necessary. (7) Improved methods for protecting metals against corrosion. (8) The re-use of old scrap by fabrication and welding.

Turning now to the inclusion of scrap metals in any general scheme for metal supplies under the Atlantic Charter, the first essential is the compilation of international statistics on an agreed basis. Even if these cannot be complete owing to the difficulty of including old scrap which is re-used by works internally, and so-called runaround scrap such as bearing metal, which circulates internally and therefore does not come into account, it should be possible to collect data for all process scrap, engineering scrap, or old scrap which reaches the market, so as to see to what extent consumption in each country can be met from virgin metal or from scrap.

The need for such statistics was emphasized in the following passage from the report of the National Resources Board of the United States appointed by President Roosevelt in 1934 : "The subject of scrap is the great blind spot of the world's metal economy. Despite the importance of secondary metals no statistics of an international character can be had. The United States is the only Government compiling figures of secondary metal production. The present annual statistics of the Bureau of Mines should be established on a quarterly or monthly basis and expanded to include stocks and consumption as well as output. This is one of the most constructive steps that could be taken for stabilization of the metal industries. Until the importance of scrap is recognized, effective adjustment of supply and demand in the metal industries will remain difficult or impossible." This was written in 1935 with special reference to the United States ; to-day, in the light of the Atlantic Charter, it has a much wider significance.

FAMILY SIZE AND SURVIVAL IN GREAT BRITAIN

By Dr. PERCY STOCKS

THE Registrar-General's first report on fertility, based on the data obtained under the Population (Statistics) Act of 1938, shows that in 1938 the reproduction rate in England and Wales, adjusted for the anticipated rates of survival of women and girls, must have been between 16 and 20 per cent below the replacement level, and that if a serious decline in the native-born population of Great Britain is to be averted, the rate must be raised to that extent within the next few years. Complete elimination of stillbirths and child deaths up to age fifteen would bring us within 6–7 per cent of the goal, but that is outside the bounds of possibility. The increase might be effected by less avoidance of marriage and by marriage at an earlier age, but if no such social changes as these occur, it can only come by increase in the average number of children per family.

The average citizen has little knowledge of a biological kind as to the best age for marriage and the most favourable spacing of children for the rearing of a healthy family, and even scientific men have to confess to a lamentable lack of concise information on these vital matters. It would be natural to expect, therefore, that any addition to such knowledge would be eagerly studied. Little comment has been made upon the facts revealed by the fertility report : such as the findings that 42 per cent of marital children born in 1938 were first children, whereas only 19 per cent were born to mothers who had already had more than two, and that the risk of stillbirth was 30 per 1,000 for first-born and less than 20 for subsequent children to mothers less than twenty-five years old, whereas for first-born children it was 45 at ages 25–34 and 87 at 35 or over. Another important fact discoverable from the Registrar-General's 1938 report is that whereas the risk of maternal death when confinement occurs between the ages of 20 and 25 is only 1·5 per 1,000 maternities, it rises to 3 at ages 30–34, to 4 at 35–39 and to 6 at 40–44. The risk of a stillbirth increases from 28 per 1,000 births when the mother's age is 20–24 to 32, 39, 54 and 70 at succeeding age groups of five years. For young mothers under 20, both risks are slightly greater than at 20–24. Here is an important fact which should be stressed, namely, that the dangers to both mother and child are least when confinement occurs between the ages of twenty and twenty-five.

The Population Act statistics can tell us little about the survival of live-born children according to family size and maternal age, and we have little reliable data on this point since the census of 1911; but this gap has now been partly bridged by a study of the records of health visitors of the maternity and child welfare area of the Administrative County of Durham for the years 1930–37 by Mrs. C. M. Burns*.

This book needs careful study, for not all the conclusions, even when in the heavy type liberally used, can be accepted as proved by the data tabulated. From the point of view of survival up to five years, the report shows that first, second and third children are best born while the mother is between twenty and thirty-five, whereas fourth and fifth children have a better chance if born to mothers of 35–39 than if born to younger mothers; but the attempt which is made to prove that the latter finding is not the result of some form of social selection is not entirely convincing.

Nor can the evidence for the statement that "high death rates are more dependent on the size of family than on the housing conditions, as measured by rooms per person or rooms per family" be accepted as conclusive. First children of miners born to mothers aged 20–29 and housed at average densities of 1·1 and 1·8 persons per room respectively suffered losses before the fifth birthday of 147 and 143 in each 1,000 live or stillborn, whereas miners' sixth to ninth children born at any age of the mother and housed at average densities of 2·2 and more than 3 per room respectively suffered losses of 201 and 238 per 1,000. But no effect of overcrowding on health would be expected until the density exceeds about two persons per room, so the equality of the first two rates proves nothing; and the rising rates in the last two groups may as well have been due to overcrowding as to rapid breeding, these being so inseparably connected as to defy any statistician to disentangle them. It has long ago been demonstrated from the national statistics that mortality of children aged 1–5 years is more sensitive to environmental conditions than is infant mortality, and there can be little doubt that the presence of five other children in an overcrowded home is more likely to enhance the risks to a young child from most infective diseases than the presence of an equal number of adults.

The evidence that longer spacing between births results *per se* in better survival seems to have been based mainly upon a comparison of 119 sixth children born to mothers aged 25–29, of whom 28 or 23·5 per cent failed to reach their fifth birthday, with 353 sixth children of mothers aged 30–34 whose non-survival rate was 17·6 per cent, and upon similar differences in survival of the five previous children. This is slender evidence on which to base a far-reaching conclusion. That rapid breeding and overcrowding are each deleterious to the survival of young children may be accepted from the evidence, but it remains unproved which of the two is the more important.

The method of basing 'death-rates' of children upon the original number of live and stillbirths of which they were the survivors may lead to strange fallacies, such as the conclusion that twin children who have survived the first year thereafter "display quite normal death-rates". The data show that 414 per 1,000 twins failed to survive a year compared with 112 per 1,000 single born, and that the 'rates' at 1–4 years were 27 and 31 respectively; but if based upon the numbers at risk to die, the true rates at 1–5 years were 46 and 35 per 1,000 respectively, which shows the conclusion to be fallacious.

A conclusion which must occasion surprise is that in small families of one, two or three children "the fall in infant death-rates during this century has been very slight". It is deduced from the 1911 fertility report, by what method is not stated, that infant mortality in 1905–10 in families with one child was then about 55 per 1,000. Actually for marriages of 2½ years average duration, 62 per 1,000 first children born alive were dead at the census, and since the average interval between marriage and the first child, when that child was born in the first five years, was 1·63 years in 1938 according to the recent official report, and is unlikely to have been less than 1·5 years in 1905–10, the original figure 62 seems a more probable estimate for mortality of first children within a year than 55. By applying the Durham infant mortality-rates for children of successive birth ranks to the distribution of 1938 births in England and Wales according to birth rank, it can be estimated that the rate for first-born children was then about 92 per cent of that for all children (53), which gives 49 as the 1938 rate among first-born. Although a fal from 62 to 49 can scarcely be described as "very slight", it is small compared with the 50 per cent drop in the total infant mortality-rate, and Mrs. Burn has at least succeeded in showing that a large part of the improvement in infant and child survival in Great Britain on which we are apt to pride ourselves must have been due to the reduction in average size of family.

Mrs. Burns has produced with great industry a work so challenging that it will be widely quoted, and for that reason it has been deemed important to pu those who study and use it upon their guard against its faults. If it is unnecessarily gloomy we shall not quarrel with it on that account, for it contains much information which is unique and timely. The fertility position has got to be faced, and we cannot hope to apply the right remedies without a diagnosis of the causes. It is cheering to read in this report, based as it is upon conditions in a depressed area, that "If marriages take place early enough it would be quite easy to produce a fairly large proportion of well-spaced families of four, five or even six children under the best 'biological' conditions".

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* Infant and Maternal Mortality in relation to size of Family and Rapidity of Breeding: A Study in Human Responsibility. By C. M. Burns. (King's College, University of Durham: Department of Physiology, 1942.) 5*s.* post paid.

PUBLIC HEALTH IN GREAT BRITAIN

By Sir GEORGE NEWMAN, G.B.E., K.C.B.

FOLLOWING precedent in time of war, the Ministry of Health under the vigorous leadership of its Minister, Mr. Ernest Brown, has just issued a "Summary Report" on the public health of Great Britain from April, 1941, to the end of March, 1942* ; this is instead of the usual annual statement by the Chief Medical Officer. It is recognized that war has the effect of re-distributing the population, affecting the incidence and mortality of disease, and producing a variety of emergency services of a temporary nature (evacuation, raid shelters, and the care of the homeless). Nevertheless, it is highly satisfactory that the health of the people of Great Britain has been more than maintained ; and this indeed has contributed substantially to the war-effort itself. This high standard is attributed largely to the improvement made in matters of health, housing, nutrition, and the wider general public services accomplished in the last two decennia. "It owes much to the improvements in housing, health and other social services that were made between 1919 and 1939, and also to all that was done during the same 20 years to educate the public in health matters." The schools of all grades, the public newspapers, the B.B.C., and the most admirable work of the Ministers of Food and Agriculture in regard to rationing, agricultural development, and domestic application, each of which is a national science and art, have co-operated ; and at the back of it all, and inspiring it all, there has been an expanding public appreciation of what is at stake in the cause of freedom. In fact, this is one of the outstanding agencies serving as a lively stimulus of public opinion ; developing a sense of devotion and service, and of mutual interdependence, necessary to a State that is set on winning a war ; this 'something' is a kind of generative 'human credit', something to bank on, which when it grows in volume and extent inevitably leads to triumph of a constructive kind of statecraft.

Consider this astonishing fact. In the midst of the international struggle which has involved us all, and all our affairs down to the smallest detail, the English people have re-discovered their sense of solidarity and essential unity in purpose, with its consequent demand on their service, not only in the fighting line but also in what has come to be thought of as the 'home front', in maintaining the fundamentals of civilized life in Christendom, and its ordinary decencies. It is most impressive and enheartening. Instead of capitulating to the monstrous demands and outrageous policy of a group of gangsters, they have suddenly found themselves and their own soul. Life is after all not hedonistic ; nor is it the common thing which they had assumed, but a great and even glorious adventure. Are we really to suppose that Russia, and America (north and south), and China (which has come down through the ages), as well as Great Britain and her Dominions, are under some delusion that a monomania of Hitlerism and his New Order is the last word in human civilization ? If so, it is a grave misapprehension.

The redistribution of population in Great Britain due to the War called for sacrifice, both from the evacuated and those who received them. The local government service accepted the strain of the duty thus imposed upon it, and its reputation for efficiency and devotion was if anything enhanced ; by 1940 and 1941, accommodation had been organized for 3 millions in public and communal shelters and 4½ millions in Anderson shelters. The absence of 'alerts' towards the end of 1941 relieved the Ministry of a most exhausting effort, central and local, and allowed it to attend to the routine duties of health.

The general health all through 1939–42 has remained excellent. The total death-rate was 12·1 per 1,000 in 1939, and 12·9 in 1941. The *infant mortality*, which by 1939 had been reduced from the 'homicidal' figures of earlier years (such as 150 per 1,000 from 1870 to 1900—involving the loss of 140,000 infant lives yearly) had come down to 90 in 1916–20 and to 60 by 1930 (that is, a loss of 38,000 children) and was in 1939 so low as 50, moving up in 1941 to 59 (representing 34,000 deaths of children less than one year of age).

The *maternal mortality*, as is well known, changed for the better in 1934. Before that date, Great Britain had been acquiescent in losing the lives of 3,000 every year, but in 1932 the figure declined to 2,500 and in 1940 to 1,640. This meant a fall in the maternal mortality from upwards of 4 or 5 per 1,000 to 2·6, the lowest on record. This welcome and extraordinary reduction is rightly attributed to improved midwifery, and especially to an improvement in the treatment of puerperal sepsis, by the use of sulphonamide. How was it done ? The answer is clear. The fall in the infant and maternal mortality was due to *better motherhood* and better midwifery practice. In other words, the physical functioning of motherhood is not hereditary, but must be learned by each mother ; and three or four years ago it was discovered, medically, that by the wise use of sulphonamides puerperal fever might be reduced. The State and voluntary agencies did their part for mothers and children by establishing infant welfare and ante-natal centres where the art of midwifery and the care of infancy might be taught ; 3,600 of these centres were established by local authorities or voluntary agencies by 1941, and they were attended by 70 per cent of all the babies born alive in that year. There were also 1,800 ante-natal clinics, and many hundreds of health visitors visited in the homes. The National Milk Scheme provided free milk for mother and baby, and eggs, free oranges and lemons, or orange juice, blackcurrant juice or purée, and cod liver oil. The Government also provided many new nurseries and contracted for others, and by March, 1942, there was new accommodation for 11,400 children ; and in addition there were 2,000 hostels provided for mothers or children, or both. The exaggerated talk about 'malnutrition', before the present War began, has died down, and what has been said here shows how keenly interested the Government has been in protecting the mother and child from any degree of under-nutrition. Investigations show nothing disquieting ; indeed the reports from many [illegible]stricts show evidence of improvement.

Owing to the rise in the incidence and mo[illegible] of *diphtheria* the Ministry has urged the public [illegible]ve children immunized against this infection. In 1941 a campaign was initiated by Sir Wilson Jameson, broadcasting the favourable experience of New York in this matter, and up to June, 1942, upwards of three million children in Britain had been inoculated.

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* Summary Report by the Ministry of Health for the Period from 1st April 1941 to 31st March 1942. (Cmd. 6394.) Pp. 35. (London: H.M. Stationery Office, 1942.) 6*d.* net.

It is curious to remember that England, the home of vaccination against smallpox, is slow to practise immunization. It waited fifty years, and lost many lives, before it used its own inventions; similarly with diphtheria and typhoid. *Tuberculosis* also has been a cause of anxiety owing to an increase of 23 per cent among industrial young women. The avoidance of droplet infection, the use of pasteurized milk, and miniature radiography in diagnosis are recommended.

Venereal disease is a still more complex problem, which tends to increase in importance in war-time. The Royal Commission of 1916 elucidated it and directed attention to the importance of early diagnosis, free treatment, the use of Salvarsan or its derivatives, and the prohibition of quack advertisements, false remedies, and unqualified practice. It also advised widespread public education, and numerous clinics, of which some two hundred were established. In March of the present year, the Central Council for Health Education was authorized to assist in the necessary educational work (see also NATURE, Nov. 7, p. 529). Notification of venereal disease was not recommended in 1916, as it tends to drive the disease underground; but its present tendency to rise in incidence is full of warning as to the need for alertness and vigilance. The reaction of the Ministry of Health to the problem is seen in a Defence Regulation (33, B.) issued on November 11 (since the "Summary Report" was published) announcing that, particularly because of the presence of numbers of service men and women from countries where treatment of venereal disease is compulsory, treatment is now made compulsory in Great Britain.

Happily this is not all. For the Minister of Health has an eye to the future reconstruction of the public health services, and his advice on this subject is much to the point. The prior aim to meet the admitted needs of mothers and children, which has proved itself most effective, is not enough; and in 1941 the Minister laid down the principles of his particular "New Order". There must be no return after the War to the confused and unrelated hospital services pursuing independent, wasteful, and competitive courses; the hospital business must be *planned* as a whole into a comprehensive and adequately integrated national service by which everyone in need will actually receive appropriate and prompt treatment. This is to be undertaken by the larger local authorities (in close co-operation with the smaller) and in recognized co-operation also with the voluntary hospitals, in areas substantially larger than those of existing local authorities. This meets the new demand for regionalization. Further, the Exchequer should give financial help, especially to hospitals undertaking the teaching of medical students or the highly specialized services of medicine, surgery and practical midwifery. To this end the Minister of Health has instituted a system of survey of the present administrative situation, beginning in the London district, and also an inquiry into organization of the medical schools, and their arrangements for clinical teaching and research. Such inquiry will not include the curriculum of medical training, already provided by the General Medical Council under Act of Parliament. Nor has the Minister lost sight of two new spheres of applied medicine, industrial and rehabilitation. We must complete our medical treatment (vocationally or otherwise) by following up effectually our remedy, so that the industrial worker who has been disabled may be returned to his job fit to continue his work, or any new work to which he may be transferred. All this is very timely and hopeful; and it envisages a long-felt need for co-operation with medicine of the rehabilitators, the vocationalists, and the medical specialists.

NEWS and VIEWS

Dr. D. R. Pye, C.B., F.R.S.

DR. DAVID RANDALL PYE, formerly fellow of Trinity College, Cambridge, and of New College, Oxford, has been appointed to succeed Sir Allen Mawer as provost of University College, London. Dr. Pye, who has been for many years connected with the scientific side of aeronautics, succeeded Mr. H. E. Wimperis as director of scientific research to the Air Ministry, which appointment was transferred by a war-time change to the Ministry of Aircraft Production. In this position he has had control of a large scientific and experimental staff, principally at the Ministry's London headquarters, the Royal Aircraft Establishment at South Farnborough, and the Aircraft Testing Station at Boscombe Down. He has also worked in collaboration with the Aeronautical Research Committee, and the National Phys[illegible] Laboratory, Teddington, and has been re[illegible]ble for maintaining the high standard of sci[illegible] aeronautical research in Great Britain.

[illegible]ye's own original scientific work was on the internal combustion engine, and he is the author of a standard work in addition to many papers on this subject. His administrative work at the Air Ministry has covered all the other branches of work associated with the development of aeronautics, and the production and use of aircraft in the widest sense. He was elected a fellow of the Royal Society in 1937, and is a past vice-president and member of the Council of the Royal Aeronautical Society. He is also one of the general editors of the Oxford Engineering Science Series of works.

Akbar, the Great Mughal

ON November 23, 1542, Akbar, the future Mughal Emperor, was born at Amarkot. His father, Humayun, had already lost the kingdom won by Babar, and Akbar's childhood was spent in exile. Humayun reconquered India in 1555, only to die, and the boy-king had to endure five years of regency before he came into his own. He stands out among Asiatic rulers as a determined leader and enlightened organizer. But the man was greater than the king. His interest in religion and philosophy, art and science is famous, but the distinguishing marks of his greatness were the questing intelligence and fearless judgment he consistently brought to bear upon the difficulties with which he was surrounded. He set himself to unite Hindu and Muslim India. He married into the ancient Rajput royal families, and

Jahangir, his successor, was born of a Rajput princess. It is worth remembering that his reign coincides almost exactly with that of Elizabeth of England. At a time when Europe still found the methods of the rack and stake acceptable, he instituted and enforced religious toleration. He grappled with the horrors of suttee two hundred years before Bentinck abolished it. He was the patron of learning and the arts. His justice knew no distinction of caste or creed or colour. Such was the man, who, while he lived, united India in mutual service. The fourth centenary of Akbar's birth will be celebrated by a meeting arranged by the British Council, the Royal Asiatic Society, the East India Association and the India Society to be held in the rooms of the Royal Society on November 23.

Discovery of a Nova

A TELEGRAM from Lund announces the discovery of a nova, magnitude 2, by Finsler and Nakahara. It is about 5° north of ζ Puppis. The telegram is dated November 13, but the time of discovery is not stated. Before receiving the telegram a telephone message which was sent by Mr. G. Ellis, Llandudno Junction, was received at the Royal Observatory, Greenwich, and this announced that Mr. Ellis, observing from a height of 400 ft. above sea-level, had discovered the nova on Nov. 13d. 4h. 25m. U.T., its approximate position being, R.A., 8h. 10 m., Dec. – 34°. Owing to its high southern declination it will not be an easy object to see in Great Britain. It crosses the meridian about 4h. 15m. U.T. on November 21, and in the latitude of Greenwich its greatest altitude does not exceed 4·5°. Mr. Will Hay has reported that he has observed the nova with the naked eye.

Documentation and Microfilm

THE *Proceedings of the British Society for International Bibliography*, Parts 1 and 2, contain the papers and discussions at the twenty-second and twenty-third ordinary meetings on March 5 and April 23 last, respectively. In Part 1, Miss M. Shaw's paper "Documentation in an Industrial Laboratory" describes the library and information service in the laboratories of Messrs. J. Lyons and Co., Ltd. The function of this library is to keep the chemical staff supplied with the most recent scientific and technical literature, to see that this is adequately catalogued and indexed, and to supply information, as well as prepare bibliographies and translations. Any books borrowed must be in the laboratories during the day so that they are available for reference if required. With regard to abstracting, the actual reading of the periodicals and selection of matter to be indexed is carried out by the chemists themselves, the periodicals concerned being issued to the sections of the laboratory in turn, for periods of 2–3 days, and 7 days for the final section, which is responsible for noting anything missed by other sections. Indexing is carried out daily in the library before re-issuing a periodical. For copying scientific papers, the Lumiere – Van der Grinten diazo process is used and has given very satisfactory results since July 1938.

Part 2 of the *Proceedings* contains a paper by B. K. Johnson describing four pieces of apparatus for use with microfilming processes. These consist of a hand viewer for the recognition of titles and general identification of the film; a viewer for table use, a microfilm projector for use by the typist when typewritten copies of a document recorded on microfilm are required, and a camera for the photography of documents, etc. In a written communication in the discussion, Mr. E. H. Lindgren stressed the importance of proper safeguards in the storage of the film and referred to an intensive technical examination of the films in his possession which is being carried out with the view of obtaining fuller information on the storage question. Mr. K. S. Smith's paper in the same part describes the airgraph service, Mr. H. J. Dowden the Gesteprint process for duplicating foreign periodicals, etc., in which the stencils are prepared by a photographic process, and a paper by H. Rottenburg on "The Typewriter as the Foundation of the Printed Book" outlines the possibilities of replacing printer's type by a typewriter and discusses the advantages.

Polarography

POLAROGRAPHIC methods continue to attract attention in Great Britain. Much knowledge has already been obtained and a concise summary of this, written in a simple objective manner, is to be found in a pamphlet, "Cambridge Polarograph", recently published by the Cambridge Instrument Company. For its size this pamphlet covers a great deal of ground and, if the theoretical background of polarography is largely omitted, this is compensated for by the presence of a considerable bibliography which contains references to most of the important papers on the subject. The difficulties of the polarographic method are not unduly emphasized; nevertheless, most of the major pitfalls are mentioned and it is frequently made clear that modifications of technique must be very critically tested. Use of the polarograph for the performance of amperometric titrations has not been overlooked.

A relatively small part of the pamphlet is devoted to a description of the Cambridge polarograph, and it is a pity that a wiring diagram of the instrument is omitted. Clearly, however, satisfactory electrical equipment is provided in a compact form to meet the needs of a present-day user of the polarograph. The text of the pamphlet is well illustrated with reproductions of actual polarograms, which give a very fair idea of the possibilities of the instrument and will no doubt stimulate the efforts of new users of the Cambridge polarograph. A table and chart of the half-wave potentials of inorganic substances, and the bibliography already mentioned, add to the value of the publication.

Spectroscopy in Astrophysics

DURING a conference on spectroscopy arranged by the University of Chicago on June 22–25, several papers described results of recent research with the aid of the spectroscope. A short account of these papers is given in *Sky and Telescope*, September, by Dorrit Hoffleit. Dr. Andrew McKellar, of the Dominion Astrophysical Observatory, has made a critical study of the intensities of bands in the spectra of Comet Hassel (1939*d*) and Comet Cunningham (1940*c*). These bands correspond to temperatures ranging roughly from 200° to 2,000° K., and further research is desirable to explain this anomaly. The use of the spectroscope in settling the composition of planetary atmospheres has been followed by numerous theories to account for the diversity in the atmospheres of the planets, assuming that they all started their evolutionary course as homogeneous fluid masses with temperatures of several thousand degrees. Dr. Rupert Wildt discusses this problem in an interesting paper, but, as might be expected with a subject of such complexity, there is a large amount of speculation in his theories. Dr. C. T. Elvey reports on spectrophotometric and photo-electric studies of the night sky, and discusses the permanent or 'non-polar' aurora, which is much less spectacular than the better known northern or southern lights. The spectra indicate that atoms or molecules of oxygen, sodium, nitrogen, nitric oxide, water, and sometimes ionized nitrogen are involved. Spectrophotometric studies, in which Dr. Alice Farnsworth collaborated, refer to radiations originating about 800 miles above the earth's surface. Photo-electric observations concern radiations from altitudes of about 200 miles. Infra-red observations of the intensity of the light of the night sky show that there is sometimes a steady decrease throughout the night, and also that such observations are associated with times when terrestrial magnetic activity is low. It is suggested that this regular variation may be explained on the theory that the radiation is caused by the release of energy when oxygen atoms combine to form oxygen molecules.

Recent Earthquakes

AN earthquake with epicentre in the Songea District (Livingstone Mountains) near Lake Nyasa, Tanganyika, was reported from Dar es Salaam on November 8. It is said to have been the most serious for many years and wrecked many buildings and a Roman Catholic mission. Damage is estimated to have been near £3,000. No casualties have been reported.

Dr. Perry Byerly of the University of California reported the registration of a very large earthquake by the seismographs at Berkeley at 8.2 a.m. Eastern War Time on November 10. The epicentre was estimated to have been 9,500 miles from Berkeley.

During October 1942 only two important earthquakes have been registered by the seismographs at Kew Observatory. These were on October 20 and 26, respectively. The former began recording at 23h. 35m. 55s. U.T. and attained a ground amplitude of 195 μ at 00h. 27m. 06s. on October 21. The epicentral distance from Kew may have been 11,200 km., but the analysis is tentative since the record was interrupted by large microseisms. The latter began recording with compressional *iP* on all three components at 21h. 21m. 19s. U.T. and attained a maximum ground amplitude at Kew of 89 μ at 21h. 56m. 57s. U.T., the recording being complete at 23h. 55m. U.T. The epicentre may have been 8,700 km. from Kew, almost in a south-westerly direction. On October 30 an earthquake shock of considerable strength was reported from Switzerland. No further details are so far available.

Reginald Farrer (1880–1920).

THE pre-war vogue of rock gardens owes much to the enthusiasm of Reginald Farrer (1880–1920). His home was in Ingleton, Yorkshire, where the natural scenery is itself a rock garden, and Farrer began to combine this beauty with horticultural concentration of colour at the early age of fourteen. Two short papers by E. H. M. Cox, one of Farrer's collaborators, and Humphrey Denham (*J. Roy. Hort. Soc.*, 67, Pt. 9; 1942) portray Farrer's life and his contributions to gardening. Having exhausted the possibilities of the European Alps, he made two expeditions to China; from that country he introduced the beautiful threepenny-bit rose (*R. Farreri*), *Buddleia alternifolia*, several species of Rhododendron, *Aster Farreri*, *Viburnum fragrans*, and many others. Aside from his botanical contributions, Farrer's life is an outstanding study in determination; he had very poor physique and was "a Yorkshireman with an inferiority complex", yet his contributions to horticulture rank among the greatest.

John Amos Comenius

ON October 24, 1941, the tercentary of the visit of John Amos Comenius to England was commemorated at Cambridge, and in NATURE of November 22 there appeared an account of Comenius, his life and work, by Dr. Gerald Druce. It was then intended that the papers read at the commemoration would be published in permanent form. This intention has been carried out by the appearance of a volume entitled "The Teacher of Nations", containing all the papers read, whether short or long (Cambridge University Press, 5*s*. net). The volume, which is edited by Dr. Joseph Needham, contains also a chronological table showing the events in the life of Comenius, by Dr. R. F. Young, and a select bibliography of the works of Comenius by Anne Heyberger.

British Rheologists' Club

AT the annual general meeting of the British Rheologists' Club, held on November 6, the following officers were elected: *President*, Dr. C. F. Goodeve; *Honorary Secretary*, Dr. G. W. Scott Blair; *Honorary Treasurer*, Dr. V. G. W. Harrison. After the formal business, Prof. E. H. Rideal gave an informal address on "Solutions of Macro-molecules". Later, simple demonstrations were given by some members of the Committee to illustrate the Club's "Table of Deformations" (NATURE, 149, 702; June 20, 1942).

Colonial Service Appointments

THE following appointments and promotions in the Colonial Service have recently been made: E. G. Cripps, agricultural officer, Nyasaland; G. R. Fenton, assistant conservator of forests, Sierra Leone; J. F. Hughes, assistant conservator of forests, Tanganyika Territory; C. C. B. Brown, veterinary officer, Tanganyika Territory; L. C. Stones, veterinary officer, Gold Coast; J. N. R. Brown (agricultural officer), senior agricultural officer, Tanganyika Territory.

Work of Scientific Men of the United Nations

THE Association of Scientific Workers is holding a conference on "Scientists of the United Nations and the War Effort" at Gas Industry House, 1 Grosvenor Place, S.W.1, on December 5 (2.30 p.m.) and 6 (11 a.m.), under the chairmanship of Sir Richard Gregory, president of the British Association. Prominent scientific workers from more than fifteen countries will give addresses on the destruction and distortion of science in the oppressed countries and will show by contrast the contribution of scientific men of the United Nations who are in Great Britain to the war effort. Applications for invitations should be sent to the secretary, Foreign Scientists Committee, Association of Scientific Workers, Hanover House, 73 High Holborn, W.C.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Effect of an Enzyme from Kidney on the Solubility of Calcium Phosphate

The precipitation of sparingly soluble salts in organs like kidney and liver can no doubt be due to a variety of reasons. In the following note an experiment is described which may possibly show the mechanism of one of them.

It has been demonstrated lately that the solubility of calcium salts is increased by amino-acids[1]. A man who keeps his calcium intake constant but eats more protein absorbs more calcium and consequently excretes more of it through his kidneys[2]. This makes it likely that a proportion of the calcium inside the body is in the form of composition compounds between amino-acids and calcium salts.

Most calcium precipitates are found in kidney and liver. These organs are also richest in enzymes destroying amino-acids[3], a process which should lower the solubility of calcium salts.

Whereas pig's kidney destroys both *l* and *d* amino-acids, the *l* amino-acid oxidase is insoluble in water and an aqueous extract will only attack the *d* compounds[3]. This fact is used to devise an experiment, which demonstrates the transformation by *d* amino-acid oxidase of soluble calcium phosphate into insoluble precipitate.

Two solutions of 20 per cent alanine are prepared, one of the *d* (−) and one of the *l* (+) compound. To 1 ml. of each are added 1 ml. *N*/10 hydrochloric acid saturated with $CaHPO_4$. The addition of 1·3 ml. *N*/10 sodium hydroxide makes the solution slightly alkaline, but no calcium phosphate is precipitated due to the presence of the alanine. Acetone powder from pig's kidney (prepared according to Krebs[3]) is extracted by ten times its weight of water. 1 ml. of the filtered extract is added to each sample; a capillary is immersed from which a constant stream of oxygen is supplied. Both solutions are left for one hour at 30° C. Only the one which contained the *d* (−) alanine shows a considerable cloudy precipitate. After centrifugation a positive nitroprusside reaction is given by the supernatant, a sign that alanine has been deaminated to pyruvic acid. The centrifugate is resuspended in dilute nitric acid and filtered. Addition of sodium acetate and sodium oxalate to the filtrate leads to precipitation of calcium oxalate.

Time factor. Whereas much of the deamination occurs in the first half-hour, most of the precipitation takes place in the second half-hour. The effect of amino-acids on the solubility of sparingly soluble salts takes time to show itself. If, for example, alanine is added to a suspension of freshly precipitated calcium phosphate, a considerable time will pass before all precipitate has disappeared. The same is true for the reverse process. This can be demonstrated in the following way. An experiment is carried out as described above, but both samples contain *d* (−) alanine. After half an hour one tube is boiled for one minute to inactivate the deaminase. It is quickly cooled down again and filtered. Almost as much calcium phosphate precipitate will appear in the filtrate within the next thirty minutes as in the untreated sample within one hour.

Another way to demonstrate the time lag between deamination and calcium phosphate precipitation is to filter a sample containing *d* (−) alanine after half an hour and to apply nitrogen instead of oxygen for the next thirty minutes. Although the amino-acid oxidase cannot act in nitrogen, precipitation of calcium phosphate will continue under these conditions. A control containing *l* (+) alanine will show no change in calcium phosphate solubility.

Some cloudiness can also be seen often in the samples with *l* (+) alanine. This is due to various reasons. One of them is denaturation of protein from kidney extract. The extract may also contain traces of iron which lead to a precipitation of ferric phosphate, the solubility of which is not influenced by alanine[1]. If after centrifugation the sediment is resuspended in acid and filtered, only traces of calcium can be discovered in the filtrate.

Biochemical Laboratory,
University of Cambridge.
H. Lehmann.

[1] Lehmann, H., and Pollak, L., *Biochem. J.* (in the press).

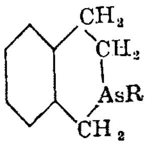
[2] McCance, R. A., Widdowson, E., and Lehmann, H., *Biochem. J.* (in the press).

[3] Krebs, H. A., *Biochem. J.*, **29**, 1620 (1935).

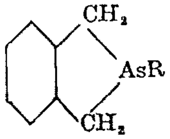
New Heterocyclic Systems

o-β-Bromethyl-benzyl bromide, $C_6H_4(CH_2Br)$-CH_2CH_2Br, has hitherto been available only by the very laborious synthesis of von Braun and Zobel[1]. We have now developed a new synthesis by which the dibromide can be prepared far more readily and in good yield. As von Braun and Zobel have shown, the dibromide condenses with primary amines to give N-substituted-1 : 2 : 3 : 4-tetrahydro-*iso*-quinolines. In view of the occurrence of the *iso*-quinoline nucleus in many natural products possessing marked physiological activity, we are now condensing the dibromide with a wide variety of amines, in order that the chemotherapeutic properties of the resulting *iso*-quinoline derivatives may be investigated.

(I)



(II)



We find also, however, that the dibromide condenses readily with alkyl (or aryl)-dichloro-arsines in the presence of metals to give stable 2-alkyl (or aryl)-1 : 2 : 3 : 4-tetrahydro-*iso*-arsinolines (I): these compounds possess a new heterocyclic system isomeric with that in the 1 : 2 : 3 : 4-tetrahydro-arsinolines discovered by Burrows and Turner[2].

We have prepared a number of such tetrahydro-*iso*-arsinoline derivatives, and are investigating the preparation of similar derivatives containing phosphorus, antimony, tin, etc., in place of the arsenic. The chemotherapeutic activity of the compounds so obtained will be tested.

o-Xylylene-dibromide also condenses with aryl-dichloro-arsines to give 2-aryl-dihydro-*iso*-arsindoles (II), but the yield of these compounds appears to be markedly less than that of the corresponding members of series (I).

University Chemical Laboratory,
Cambridge.
F. G. Mann.
F. G. Holliman.
D. R. Lyon.

Oct. 26.

[1] *Ber.*, **56**, 2142 (1923).

[2] *J. Chem. Soc.*, **119**, 430 (1921).

Superconductivity and Liquid Helium II

WHEN discussing our observations on the transfer of liquid helium II along solid surfaces above the liquid level[1], we pointed out that this mechanism of surface flow might also be responsible for the 'transport phenomena' in the bulk liquid (high heat conduction, low viscosity and the fountain effect)[2]. Subsequent experiments by ourselves[3], Allen and Reekie[4] and by Kapitza[5] strongly support this assumption. It appears that the transfer film observed above the liquid level also extends below it, covering all solid surfaces in contact with liquid helium II, and it is evidently in this film that the anomalous transport phenomena take place.

It has been suggested by F. London[6] that the λ-phenomenon in helium may be caused by the existence of helium atoms of very low (or zero) thermal energy, and the mechano-caloric effect found by us[3] strengthens this view. This effect shows that by flow along a solid surface, such thermally 'unexcited' atoms can be separated to a certain extent from the bulk liquid.

In elaborating our hypothesis we have now come across a striking analogy between the phenomenology of liquid helium II and superconductivity, which seems to go much farther than a superficial similarity. While we have a good deal of information on the superconductive state, our knowledge concerning liquid helium II is very limited. A certain amount of generalization has thus been necessary in the formulation of our thesis, which therefore must be considered as of an approximate nature only. The main points of the analogy are as follows:

(1) As it is impossible to establish a difference of electrical potential at the ends of a superconductor, so it is impossible to establish a temperature difference along the transfer film of helium II.

(2) In both cases the frictionless transport of particles (electrons or atoms) breaks down as soon as a certain value of flow is exceeded. This limiting value is given by the current threshold in superconductors, J, and by the rate of transfer, R, in helium[1].

(3) In both cases this limiting value of flow is solely dependent on temperature and is independent of the length of the path the particles have to travel. It is directly proportional to the width of the connecting surface (this holds rigidly for plane surfaces, whereas for curved surfaces the limiting rate of flow will be reduced in both cases).

(4) In liquid helium as well as in superconductors, the frictionless transport seems to be confined to the geometrical surface of the substance. Kapitza[5] has demonstrated that an anomalously high heat conduction does not take place in the bulk of helium II; that is, there is no frictionless transport of atoms unless this can take place along a solid – liquid boundary surface. An analogy to this exists in a superconductor, since it seems theoretically impossible to remove an electric charge from inside a completely closed superconducting shell except by the process of normal conduction.

(5) It appears that in both cases the maximum current density of flow on the surface (J, R) indicates the number of particles which can at each temperature be transported frictionlessly (provided one assumes the particles to have velocities independent of temperature). The threshold curve and the curve giving the temperature dependency of R will therefore play an identical part in the treatment of both phenomena. Indeed the shape of these curves is similar; they both start with a finite slope at the temperature at which the first anomalous behaviour is evident, and they both become temperature independent near absolute zero.

(6) When developing the thermodynamics of a superconductor with the current density rather than the magnetic field as the variable of state, one arrives at a formalism which also fits well the observations in liquid helium II. While the rigorous derivation of this cannot be given here, it appears that R^2 assumes the same significance in determining the free energy of liquid helium II as the square of the threshold field has for superconductors[7].

(7) One would expect that in such a model the specific heat of the system of superconductive electrons as well as that of the 'unexcited' helium atoms would be zero. This seems actually to be the case. The facts that a super-current in a temperature gradient produces no Thomson heat[8] and that no heat transport exists in a helium film in a direction opposite to that of the flow[1] strongly suggest that no heat is transferred to the particles while they remain in the anomalous state. We ascribe the observed high specific heat of superconductive metals and liquid helium II to the energy taken up in lifting particles from the lowest state into thermal equilibrium with the rest of the substance.

The question naturally arises what physical significance has to be given to this striking analogy. It seems to us that the fundamental phenomenon is the passing at finite temperatures of a number of particles into the lowest quantum state, where no energy exchange can take place between them and the remainder of the substance. This new form of aggregation of matter evidently follows quite general rules, so that the fact that the particles are electrons in one case and atoms in the other is only of secondary importance. The phenomenon of frictionless transport confined, as it is in both cases, to the geometrical surface, might be explained by the fact that, as the particles are free from interaction with the bulk of the substance, they can only be accelerated by external forces. The range to which these external forces can penetrate the substance limits the layer in which the transport takes place. Thus, in a superconductor, electrons can only be moved within the depth of penetration of an external magnetic field[9], while the flow in a helium film is limited by the extent of the van der Waals' forces of the container. It appears from these considerations that the theoretical interpretations of the superconductive state and of the λ-phenomenon in liquid helium II should be similar in their fundamental aspect, and it is with regard to such a generalized theoretical treatment that we hope the analogy pointed out in this note will be of value.

J. G. DAUNT.
K. MENDELSSOHN.
Clarendon Laboratory,
Oxford.

Nov. 5.

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[1] Daunt and Mendelssohn, *Proc. Roy. Soc.*, A, **170**, 423 (1939).

[2] See, for example, Darrow, *Rev. Mod. Phys.*, **12**, 257 (1940), and Jones, "Reports on Progress in Physics", **6**, 280 (1940).

[3] Daunt and Mendelssohn, NATURE, **143**, 719 (1939).

[4] Allen and Reekie, NATURE, **144**, 475 (1939).

[5] Kapitza, *J. Phys. U.S.S.R.*, **4**, 181 (1941).

[6] London, F., *Phys. Rev.*, **54**, 947 (1938).

[7] Gorter and Casimir, *Physica*, **1**, 305 (1934).

[8] Daunt and Mendelssohn, NATURE, **141**, 116 (1938).

[9] London, H., *Proc. Roy. Soc.*, A, **152**, 650 (1935).

Tensile Strength of Water and Liquid Structure Theory

THE following note arises out of work in this Department examining erosive action from the point of view of liquid structure theory.

In a recent paper[1], R. Fürth suggests a theory of liquid structure in which holes in a continuum are treated by statistical mechanics. The picture of the theory is almost the reverse of the kinetic theory of gases, since holes move in a continuum instead of particles in a void. The holes are, however, supposed to contain vapour at the vapour pressure corresponding to the temperature.

Fürth's treatment indicates the existence of the known metastable state in which the temperature exceeds the saturation value corresponding to the pressure, the vapour pressure exceeding the hydrostatic. For the limit of this metastable state he obtains the defining equation

$$p_0 - p^* = \frac{1 \cdot 3\sigma^{3/2}}{\sqrt{kT}}, \quad . \quad . \quad . \quad (F.27)$$

where p_0 is the vapour pressure corresponding to the temperature T, σ is the surface tension, p^* is the hydrostatic pressure and k is Boltzmann's constant.

Substituting the value of surface tension for water at the region of normal atmospheric temperature (10° C.), we obtain a pressure difference of 80,000 lb./sq. in. If p^* is considered to be atmospheric pressure, the excess of vapour pressure demands a high temperature before it can be realized, and in this case has little meaning since the pressure is above the critical. Actually, however, the right-hand side needs to be altered to allow for different T, including the variation of surface tension, and the two sides become equated for water at about 337° C., where p_0 is about 2,000 lb./sq. in.

In practice, this order of superheat has not been obtained, due to the presence of particles and dissolved gas. The highest value is of the order 180° C. recorded for water in the form of a globule suspended in oil at atmospheric pressure[2].

Equation $F.27$ may, however, be regarded from another point of view. It is generally taken that the hydrostatic pressure p^* is not less than zero and therefore that $p_0 - p^*$ cannot be greater than the vapour pressure at temperature T. But if p^* could be taken to be negative this conclusion would not follow. The above data indicate that $F.27$ would be satisfied were p^* of the order $-$ 80,000 lb./sq. in., since p_0 at 10° C. is then negligible.

This suggests that the liquid should theoretically carry a tensile stress up to the limit of p^*. From the above figures the theoretical limit suggested at usual temperatures would be of the order 80,000 lb./sq. in., that is, 35 tons/sq. in. Again, however, the disturbing influence of particles and dissolved gases in promoting evaporation will give an actual limit which may be much less. Using the ordinary equations for the equilibrium of a bubble of radius r, the tensile limit suggested will be between $2\sigma/r$ and $4\sigma/3r$. Even radii so small as 10^{-4} cm. would make this limit of order less than one atmosphere, and in ordinary circumstances evaporation nuclei much greater than this exist in water. Thus the tensile stress which can be maintained by water is negligible.

While nuclei may exist, evaporation will not occur unless a suitable temperature distribution is formed to allow the conduction of heat into the nucleus, and that at a limited rate governed by the distribution and by the surface area. Hence a tensile stress above the limit imposed by the nuclei may persist for a short time, and the value attained would seem to depend on the relative times for evaporation and for growth of the stress. The suggestion is, therefore, that the ultimate limit corresponding to p^* derived from Fürth's theory could be carried for an infinitesimal time and hence would be transmissible as a tensile wave of rectangular wave front. A very steep tensile wave front could be expected, therefore, to be transmissible through water. Some evidence on explosion waves in water suggests that a considerable tensile wave is transmitted. Poulter[3] cites experiments indicating "several hundred kilogrammes per square centimetre", but no precise data appear to have been published.

R. S. SILVER.

Research Dept.,
G. and J. Weir, Ltd.,
Glasgow, S.4.
Oct. 26.

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[1] *Proc. Camb. Phil. Soc.*, 37, 252 (1941).

[2] Ewing, "Thermodynamics for Engineers", second edition (Cambridge University Press, 1936), p. 347.

[3] *J. Appl. Mech.*, 9, A33 (1942).

Iron Electrode Potential in a Magnetic Field

REFERENCE is made in text-books on magnetism to experiments by Paillot[1] and others in which potential differences such as 0·05 volt for 30,000 gauss were obtained between an iron electrode in the field and another which is not. It seems, however, that one should expect only the much smaller potential difference calculable by equating the magnetic energy change involved per c.c. (7·8 gm.) of iron (which is $(\mu - 1)H_2/8\pi$) with the corresponding electrochemical energy (which is $V \times 10^8 \times 7{\cdot}8 \times 10^{-1}/0{\cdot}000289$), whence we get $V = (\mu - 1)H_2 \times 1{\cdot}5 \times 10^{-13}$ volts, the values for various fields being :

$H =$	100	1,000	10,000	30,000 gauss
$\mu - 1 =$	180	21	*c.* 2·0	*c.* 0·5
$V \doteq$	0·26	3·1	*c.* 29	*c.* 67 microvolts

In testing the matter it was decided to use a permanent magnet, in spite of its lower field, so as to eliminate the possibility of stray potential differences from magnet coils. Preliminary trials with iron wire electrodes in a narrow cell, which could be slid between the pole-pieces of the magnet (*c.* 0·5 cm. apart) so as to put the two electrodes in the field alternately, gave potential differences of the magnitude found by Paillot, but rather irregularly and so slowly built up as to suggest that they were due to subsidiary causes such as reaction between ferrous salt and oxygen. This was proved to be the case by using a ferrous solution ($M/2$ $FeSO_4$) set by gelatine with a paraffin seal excluding air. Then a potential difference of about 2·7 μV. was regularly given as the field was switched from one electrode to the other. A first series of twelve rough observations gave the (single-direction) potential difference as 1·24 (± perhaps 0·2) μV., which corresponds to a field of 430 (± 70) gauss ; a second series of twenty-one better observations gave the value 1·35 (prob. error ± 0·07) μV., corresponding to a field of 480 (± 24) gauss : these values agree well with the result of determinations with a modified Quincke 'hydrostatic balance', which gave the field as 470 (± 40) gauss.

The small potential differences of this effect were observed by microscopic reading of the pointer of a moving coil galvanometer (with phosphor-bronze strip, not pivot, suspension), the resistance of the circuit reducing the correspondence of one division of the eyepiece to 5·5 μV.—specimen readings being:

+ 0·45 0·80 0·75 0·70 0·60 0·80
− 0·50 0·65 0·65 0·20 0·35 0·70,

these being 'drift' usually.

It is evident, then, this magnetic effect affords no insight into the mechanism of magnetism.

A. L. PARSON.

Hill Croft,
Allonby, Maryport,
Cumberland.
Oct. 25.

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[1] *Comptes rendus*, 1900-1.

Chlorosis in Tomatoes

IN the west of Scotland, chlorosis of the leaves of tomato plants has been widespread during the past season and has been investigated at the West of Scotland Agricultural College, Auchincruive, Ayr.

Abnormal leaves of affected plants showed a characteristic appearance; the vascular system with a strip of adjacent lamina and the leaf margins remained green while the interveinal areas became a bright yellow colour (sometimes greenish-yellow).

In extreme cases the margins of the leaf also lost their chlorophyll, but the vascular system and adjacent lamina were not observed to lose chlorophyll under normal conditions of cultivation.

The chlorosis appeared first as small yellowish-green areas in the interveinal tissues and the leaves eventually became brittle and tended to die prematurely. The leaves immediately above the third truss were the most affected. Chlorotic plants produced less fruit on the upper trusses than did normal plants, and although unaltered in flavour, the fruit was smaller than usual. The composition of the lamina of normal and chlorotic leaves is given in the appended table and it is clear that the amount of magnesium in the chlorotic lamina is less than that in the normal.

COMPOSITION OF THE LAMINA OF NORMAL AND CHLOROTIC LEAVES.

	Dry matter %	Ash % in dry matter	Ash % in original	Nitrogen % in dry matter	Nitrogen % in original	P_2O_5 % in dry matter	P_2O_5 % in original
Normal lamina	13·25	27·32	3·62	0·046	0·0061	1·38	0·18
Chlorotic lamina	13·05	22·75	2·97	0·036	0·0048	0·82	0·11

	K_2O % in dry matter	K_2O % in original	CaO % in dry matter	CaO % in original	MgO % in dry matter	MgO % in original
Normal lamina	5·45	0·72	9·07	1·20	0·43	0·056
Chlorotic lamina	6·34	0·83	6·21	0·81	0·10	0·013

With regard to the factors causing the chlorosis it was observed that only plants bearing a large amount of fruit on the first few trusses were chlorotic, although all such heavy bearing plants were not affected. It was seen also that the chlorosis usually appeared when the fruit of the first three trusses was almost fully developed, that is about the first week of June, and at that time the plants were still growing vigorously. The leaves produced by the plants in the latter part of the season, when yields were fairly small and active growth much diminished, were not chlorotic. It would seem, therefore, that the chlorosis is the result of extensive physiological drain to a large maturing crop of fruit and to actively developing leaves.

In our opinion the chlorosis is due to a deficiency of magnesium, although it should be borne in mind that the relatively small amount of magnesium in the lamina of abnormal leaves may be the result, and not the cause, of the chlorosis. That the chlorosis is a result of magnesium-deficiency is supported by the similarity between the chlorotic plants and plants which were grown in magnesium-deficient sand cultures, and by the comparable symptoms of naturally occurring magnesium-deficiency diseases of tobacco, potato and other plants. The amounts of replaceable magnesium were estimated in soils in which chlorotic plants were growing and the values obtained were high. The chlorosis, therefore, does not appear to be due to a deficiency of magnesium in the soil but rather to the plants being unable to absorb sufficient when the physiological demand is great.

Poor root action also appeared to play a part in the production of the chlorosis. This was indicated by the chlorosis often being associated with the presence of root rot fungi, poor physical condition of the soil and low soil temperature, all of which would reduce the ability of the plants to absorb magnesium.

Attempts were made to control the chlorosis by injecting solutions of magnesium salts but results were not satisfactory, although the injections did improve the condition of the chlorotic leaves to a slight extent. Further, chlorotic and normal leaves were rooted in sand and watered with culture solutions containing various ratios of potassium and magnesium, and with solutions free from these elements. These leaves remained in sand culture for three months and observations made during this period indicated that the chlorotic condition was associated with low magnesium and apparently also with a high potassium – magnesium ratio. The view that the absorption of magnesium is closely connected with the potassium – magnesium ratio in a culture or soil solution receives support from several sources. D. D. Brown[1] in his work on wheat showed that high concentrations of potassium in sand cultures reduced the amount of magnesium absorbed by the plants. Also, many workers have shown that when the concentration of potassium in soils and culture solutions is low, plants tend to accumulate magnesium. Further, the soils in the west of Scotland in which the chlorosis appeared showed a very high concentration of potassium (0·1–0·3 per cent K_2O often being present), and soils containing less potash tended to produce healthy plants, always provided that the other growth factors were satisfactory.

It is interesting to note that the chlorosis appeared on soils having widely divergent *p*H values and that it was not influenced by liming.

The conclusion reached is that the chlorosis is due to a temporary deficiency of magnesium in the leaves resulting from physiological drain of the available magnesium from mature leaves to fruit and immature leaves. Poor root action and lack of balance between potassium and magnesium ions in the soil appear to be contributory causes.

B. T. CROMWELL.

Department of Horticulture,

J. G. HUNTER.

Department of Chemistry,
West of Scotland Agricultural College,
Blythswood Square,
Glasgow, C.2. Oct. 30.

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[1] *Soil Sci.*, **26**, 441 (1928).

Determination of Moisture Content

THE recent communication[1] on this subject prompts me to describe more fully a method for moisture determinations that was mentioned in an earlier letter[2].

The method as applied to a variety of substances used in confectionery manufacture consists of "mixing a suitable quantity (usually 5 grams) of material (warmed in the case of syrups, to reduce the viscosity) with an approximately equal weight of absolute alcohol, followed by five hours drying at 105° C. in a well ventilated oven." At this temperature decomposition, as shown by darkening, is slight even with acid sugar-containing substances. Slight increases in temperature above 105° C. greatly increase the amount of decomposition. The method gives reproducible results, and while after five hours absolute constancy of weight is not attained, losses after this period are very slight. The method is clearly not applicable to living plants or animals, as the nature of the material often prevents rapid and intimate mixing with the alcohol. For powdered material it appears an admirable method, especially for routine work when some fairly rapid, but not time-consuming, method is needed.

This method of moisture determination was introduced to me by Mr. H. R. Jensen.

L. G. G. WARNE.

Botanical Department,
The University,
Manchester, 13. Nov. 5.

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[1] Hallsworth, E. G., and Reid, R. L., NATURE, **150**, 524 (1942).

[2] Warne, L. G. G., NATURE, **148**, 594 (1941).

The Saqqara Graph

SINCE my communication published in NATURE of October 17, p. 460, an excellent example of an ancient Egyptian arch has come to hand in Plate 17 of Glanville's "Legacy of Egypt"[1], a photographic print of an imitation of matting in faience and stone on a panel from a gallery in the Step Pyramid at Saqqara. On testing the upper arc of this arch, I find that it is undoubtedly developed from a 5-unit circle in the way I suggested for the arch of the Saqqara graph.

Taking the height of the arc in the plate as 22¾ mm. ($= aX = 2$ units), the base, YXY, of the parent circular arc is 91 mm., and the radius 56⅞ mm. Erect twelve ordinates, 7 mm. apart, on YY, and then ordinates of the same height, but 8 mm. apart, on a base of 104 mm. The resulting segment is practically identical with that of the plate, the ordinates coinciding with the pillars of the arch.

This illustration of the use of the 3–4–5 right-angled triangle as a basis of arch construction is convincing, since the arch provides the evidential measurements. It comes from the same place, Saqqara, as the graph, and is of the same period, being variously ascribed to the IIIrd or IVth Dynasty.

R. S. WILLIAMSON.

Graywalls,
Okehampton,
Devon.

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[1] "The Legacy of Egypt", edited by S. R. K. Glanville. (Clarendon Press, Oxford.) Plate 17 comes in Chap. 5, written by R. Engelbach.

Role of Protozoa in the Activated Sludge Process

VARIATIONS in the biological activity of activated sludges have been ascribed to a number of causes, and attempts have been made to relate the presence of characteristic organisms to the activity of the sludge. Reynoldson[1] found that under the conditions existing at the Huddersfield Sewage Works, the logarithm of the Vorticella count in the activated sludge closely followed its biological activity, as measured by the purity of the effluents produced.

Pillai and Subrahmanyan[2] claim that the ciliate Epistylis is not only of paramount importance in influencing the actual oxidative processes performed by activated sludge, but also that it surpasses all other organisms in its ability to cause flocculation. It is worth noting that flocculation may be responsible for 40 per cent of the total purification effected by the sludge[3].

Examination of various types of activated sludge, produced under different conditions, lead me to conclude that the scanty knowledge available of the nutrition and development of Protozoa in activated sludge does not justify sweeping generalizations relating the protozoan count to biological activity. One activated sludge which has produced effluents of uniform composition over a period of many months sometimes contains relatively few classes of Protozoa, with a species of Epistylis preponderating, whereas at other times the protozoan fauna has been completely dominated by Paramecium, in numbers so great as to form 5 per cent or more of the bulk of the sludge. However, flocculation and oxidation proceed satisfactorily in the absence of Protozoa. It is still possible that the Protozoa play an important part in maintaining bacterial activity at a high level, but this has yet to be proved to occur in activated sludge.

The point I wish to make is that there is ample scope for a systematic study of the protozoan fauna of activated sludge, and its influence on the activity of the sludge.

S. H. JENKINS.

Birmingham Tame and Rea District
Drainage Board,
Rookery Park,
Birmingham, 24. Nov. 14.

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[1] Reynoldson, T. B., NATURE, **149**, 608 (1942).

[2] Pillai, S. C., and Subrahmanyan, V., NATURE, **150**, 525 (1942).

[3] Jenkins, S. H., and Roberts, S. J., *J. Soc. Chem. Ind.*, **58**, 225 (1939).

RESEARCH ITEMS

Heterogeneity in Wheat Germ and High B_1 White Flour

In a paper "The Vitamin B_1 and Riboflavin Contents of Wheat Germ" just published (*Chem and Ind.*, September 1942), J. J. C. Hinton has shown that the two fractions of wheat germ, scutellum and embryo, differ in physical properties. More important is the fact that their B_1 contents are very different, that of the scutellum averaging 40 I.U. per gram and of the embryo 4 I.U. per gram. The riboflavin values, on the other hand, are roughly constant at 15 γ per gm. This work is of fundamental importance in flour milling, and T. Moran in an article published in *Milling* (October 10, 1942), has shown its application to Canada-approved white flour and high B_1 white flours generally. Nutritionally the ideal white flour would appear to be one containing the full amount, roughly 1½ per cent, of scutellum; the precise milling procedure necessary to obtain such a flour is a pretty problem in milling engineering. In dry milling, such as is now general practice in the milling of National flour, the scutellum adheres tenaciously to the adjoining endosperm and, therefore, probably finds its way into the finished meal. This is the explanation of the relatively high B_1, averaging 1·10 I.U. per gram, value of National flour.

Integument of Insects and the Entry of Contact Poisons

V. B. Wigglesworth has recently published the results of some interesting work on this subject (*Bull. Entom. Res.*, 33, 205–218; 1942). He deals in particular with certain structural and physiological features of insect cuticle and their relation to the entry of contact insecticides—in special extracts of pyrethrum in oil. It is found that, as a rule, insects immersed in oils exude minute droplets of water over the surface of the cuticle. Factors governing the rate of entry of pyrethrum through the cuticle have been studied by the application of this substance in oil to a restricted area of the abdomen of the bug Rhodnius. Entry is more rapid in light than in heavy petroleum oils, but is very slow in vegetable oils. There are great individual variations, due chiefly to the thickness of the endocuticle and other factors. There is also evidence that the pore canals are important in connexion with the passage of pyrethrum through the endocuticle. Histological examination of the integument shows that, in the nymphs of Rhodnius, oils are first taken up by the epidermal cells around bristles and later by the general epidermis. The uptake of oil is much increased by adding 5 per cent of oleic acid to refined petroleum. Among adult Rhodnius, soon after ecdysis, oils are taken up by the general epidermis, whereas in old insects they are taken up only by the dermal glands.

Parthenocarpy Induced by Frost in Pears

The occurrence of frost when fruit trees are in bloom is generally regarded as detrimental if not disastrous. However, D. Lewis (*J. Pom. and Hort. Sci.*, 20, 40; 1942) has shown that in some cases it may be instrumental in producing a crop. Among pear varieties, Conference and Fertility are usually regarded by growers as self-fertile, but indoor tests at the John Innes Horticultural Institution have shown them to be highly self-sterile. Outdoor tests under isolated conditions, on the other hand, resulted in the production of fruits by both varieties after self-pollination. The Fertility fruits were seedless whereas those of Conference dropped before full maturity. It was noticed that the styles of many of the flowers of the outdoor trees were blackened by frost at the time of pollination and it seemed likely that parthenocarpic fruits had been developed by the action of cold. This hypothesis was tested by keeping individual branches of potted trees at low temperatures from 0° C. to −9° C. for varying periods. Out of nineteen flowers kept at −9° C. for 18 hours, nine swollen fruits were produced, of which two reached maturity. These were good, well-shaped specimens, but contained no seeds and only traces of ovules. At other temperatures many fruits were produced but dropped in June before reaching maturity. It is concluded that cold stimulation may play a great part in maintaining regular bearing in some pear varieties. In a cold spring in which insects are not active to effect cross-pollination, a frost at the time of flowering, instead of doing damage, may be the making of a good crop.

Volatile Products from Apples

Ethyl alcohol, acetylene and ethylene are among the volatile substances known to be evolved from ripening apples. The latter is of considerable commercial importance because of its ability to initiate ripening in green fruits and cause injury to the skin of ripe apples. Other substances as yet unidentified are presumed responsible for the appearance of 'scald'. L. P. Walls (*J. Pom. and Hort. Sci.*, **20**, 59; 1942) has improved on the current methods of estimating these volatile products by using sulphuric acid, activated by the addition of 2 gm. silver sulphate per 100 ml. as an absorbing agent. Preliminary tests with a stream of air containing ethylene (1 in 10,000) showed that more than 90 per cent of the ethylene was absorbed. The condensable and odorous products from King Edward VII and Laxton's Superb apples were absorbed in a preliminary trap of ordinary sulphuric acid, which accounted for about one third of the total volatile products. Most of the remaining two thirds was absorbed in a second trap containing activated acid. This acid reacted quantitatively with chromic acid giving acetic acid in amounts agreeing with the assumption that the bulk of the absorbed substance was ethylene. It is concluded, therefore, that ethylene forms a high proportion of the volatile substances produced during the storage life of the apple. By the use of adsorbents, the production of volatile substances more readily condensable than ethylene and of possible importance in relation to scald was confirmed. Among these the acetic and formic esters of amyl alcohol were identified.

Auxin and Leaf-Protein

A number of hypotheses have been advanced concerning the substances from which auxin is released in the plant. S. G. Wildman and S. A. Gordon (*Proc. Nat. Acad. Sci.*, 28, 217; 1942) have shown that proteolytic enzymes release auxin from the proteins in the leaf of spinach. Proteins from both cytoplasm and from the chloroplasts release auxin after enzymatic hydrolysis by tryptic extract, trypsin and chymotrypsin. Papain produced little hydrolysis at *p*H 4 or 6. Diffusion experiments indicate that leaf auxins and the auxins released from the protein of the leaf are similar and of lower molecular weight than indol-acetic acid.

Systematics of Polychæta

OLGA HARTMAN has examined critically fifty type specimens of Polychæta in the United States National Museum ("The Identity of some Marine Annelid Worms in the United States National Museum", *Proc. United States Nat. Mus.*, 92; 1942). The species have been minutely examined, and emended descriptions are given in most cases. Among these type specimens is *Phyllodoce fragilis* Webster, and it is interesting to learn that the author has collected this species frequently at Beaufort, N.C., where it has a tendency to mass together in the interstices of oyster clumps. One new species is proposed, *Lumbriconereis moorei*, for two fragmentary specimens allied to, but not identical with, *L. minuscula* Moore. These occurred in 1,350–2,182 fathoms off Catalina Island and possess greatly elongated setæ in the anterior segments—a characteristic apparently of certain deep-water forms, or, possibly, of a unique type of substratum. Most of those with this particular feature occur on blue mud. E. and C. Berkeley publish a list of Polychæta collected at the northern extremity of the west coast of North America ("North Pacific Polychæta, chiefly from the West Coast of Vancouver Island, Alaska and Bering Sea", *Canad. J. Res.*, 20, No. 7; July 1942). There are interesting remarks connected with some of the species. Observations on *Phyllochætopterus prolifica* Potts confirm Potts's own supposition that although he observed no individuals with sexual products (having described in some detail the process of asexual reproduction) this was probably due to insufficient examination. The present work shows that mature individuals of both sexes have frequently been found in tubes. There are four new species in this collection, including two of Pista, *P. pacifica* and *P. moorei*.

Mycological Taxonomy

A STUDY of type species of agaricaceous genera by Rolf Singer (*Lloydia*, 5, No. 2; June 1942) utilizes modern conceptions of the presence of clamp connexions in hyphæ, and the presence of starch or other substances in spores, as practical diagnostic characters even in old, dried herbarium specimens. Most of the types studied are peculiarly American, but the British mycologist can obtain useful ideas on taxonomy in general, for several keys to small groups of genera are given, upon the above criteria. Fifty-two new species of fungi from Florida are described in the same number of *Lloydia* by Wm. A. Murrill. These are named according to American groups, but are mainly included under Saccardo's genera Psathyra, Panæolus, Galera, Tricholoma, Clitopilus, Volvaria, Hygrophorus and Collybia.

Cultivation of Derris in India

THE main toxic constituent of derris is rotenone, but along with it are several other related toxic substances. These substances have, hitherto, been found to occur in only a few species of plants belonging to the natural order Leguminosæ. T. P. Ghose in a communication entitled "A note on *Derris* and other Rotenone Bearing Vegetable Insecticides, their Occurrence and Possibilities of Cultivation in India", has discussed this subject (*Indian Forest Leaflet*, No. 20 (Chemistry). Forest Research Institute, Dehra Dun, 1942). It appears that search for such rotenone-bearing insecticides has resulted in the discovery of rotenone in the following plants that are indigenous to India: *Derris ferruginea*, *Millettia pachycarpa* and *Tephrosia candida*. The existing material is sufficiently rich for the preparation of efficient fluid or powder insecticides. It is suggested that by selection of suitable strains and by proper cultivation it may be possible to improve the rotenone content of the above mentioned species. Furthermore, several localities in India have suitable climatic and soil conditions to warrant the introduction and cultivation of richer varieties of commercial derris such as *Derris elliptica* or *D. malaccensis* indigenous to Malaya. Experiments have been carried out that yielded encouraging results in Mysore, Cochin and Assam.

Copper-bearing Protein in Cow's Milk

THE presence of copper in tissues is known to be essential for the formation of hæmic iron in animals and to play a part in the form of copper proteins as oxidases in plants. The presence in animal tissues of a non-hæmin iron associated with copper as a copper-iron nucleoprotein is reported. Cow's milk contains 0·09–0·17 mgm. of copper per lit., and W. L. Dills and J. M. Nelson (*J. Amer. Chem. Soc.*, 64, 1616; 1942) isolated from it a protein containing about 15 per cent of nitrogen and 0·19 per cent of copper. Dialysis showed that the copper was non-ionic. Enzymatic activity was not found either in relation to ascorbic acid oxidase activity or polyphenolase activity.

Ester Hydrolysis

THE reactions between tertiary butyl and benzyl nitrates with water and hydroxyl ion differ; in the first case, hydrolyses to alcohol and to olefin occur:

$$C_4H_9ONO_2 + 2H_2O = C_4H_9OH + H_3O^{\cdot} + NO_3' \qquad (A)$$

$$C_4H_9ONO_2 + H_2O = C_4H_8 + H_3O^{\cdot} + NO_3', \qquad (B)$$

whilst in the second no olefin is produced but the alcohol-forming reaction is accompanied by a first order reaction giving benzaldehyde and nitrous acid:

$$C_6H_5CH_2ONO_2 + 2H_2O = C_6H_5CH_2OH + H_3O^{\cdot} + NO_3' \qquad (C)$$

$$C_6H_5CH_2ONO_2 = C_6H_5CHO + HNO_2; \qquad (D)$$

and second order reactions with hydroxyl ion:

$$C_6H_5CH_2ONO_2 + OH' = C_6H_5CH_2OH + NO_3' \qquad (E)$$

$$C_6H_5CH_2ONO_2 + OH' = C_6H_5CHO + H_2O + NO_2' \qquad (F)$$

G. R. Lucas and L. P. Hammett (*J. Amer. Chem. Soc.*, 64, 1928; 1942) show that the kinetics of the reactions strongly indicate identical mechanisms for the *t*-butyl nitrate and halides, the latter previously investigated by Ingold and collaborators (*J. Chem. Soc.*, 925, 960 f.; 1940). No appreciable reaction with hydroxyl ion or catalysis by acids was observed. It is shown that perchlorate ion accelerates the reaction but hydroxyl ion retards it, and other ions have intermediate effects which parallel their effects on the activity of water in the medium. This materially weakens a kinetic argument previously used for a free carbonium ion intermediate in hydrolytic reactions. The kinetics of hydrolysis of benzyl nitrate to benzyl alcohol suggests that the reaction partakes more largely of true hydrolysis rather than displacement of anion by a water molecule than does that of the halide. There is pronounced acceleration by hydroxyl ion but acids have no effect. These results suggest that the explanation of the mechanism of ester hydrolysis is less final than has recently been supposed.

INSECT FAUNA OF A BRINE-PIT

By FREDERICK BURKE

THE brine-pit[1] described is apparently a disused well from which brine was formerly pumped (Fig. 1). It is situated on the south side of Wych-brook, the boundary between Cheshire and Flintshire (detached), and about two miles south of Malpas. The pit is roughly circular in shape with an approximate diameter of 25 ft. According to Ormerod[2], it was sunk through clay to the depth of 450 ft., or 300 ft. below sea-level. In May 1941, during a preliminary visit, numerous dipterous larvæ and pupæ were discovered in the pit water. Analysis of the water, at that time, showed a salinity of 9,400 parts per 100,000. So far as can be ascertained, little attention appears to have been directed, in Great Britain, to the insects inhabiting pools of high salinity such as are to be found in parts of Cheshire. Pending a more detailed account, therefore, the following notes have been compiled from observations made over a period May 1941—August 1942 inclusive. During this period the pit has been visited on nine occasions.

TABLE 1.

Date of sampling	*p*H value (Lovibond comparator)	Sodium chloride Parts per 100,000	Total salts Parts per 100,000
18/5/41	7·2	9,400	— †
15/6/41	6·4	9,500	10,200
20/7/41	7·8	9,100	— †
31/8/41	8·7	9,100	— †
12/10/41	8·0	7,900*	8,500
14/12/41	8·0	8,000*	8,800
2/5/42	6·5	9,400	10,300
21/6/42	7·5	9,500	10,400
16/8/42	8·5	9,400	10,300

* Samples collected after a period of very wet weather.
† Undetermined.

TABLE 2.

Depth	*p*H value (Lovibond comparator)	Sodium chloride Parts per 100,000	Total salts Parts per 100,000
Surface	8·5	9,400	10,300
10 ft.	7·0	9,300	10,200
20 ft.	6·5	9,300	10,200
30 ft.	6·5	9,300	10,200

Analytical values for surface samples of water collected at each visit are given in Table 1. Values for samples collected with a Meyer's bottle[3] from 10, 20 and 30 ft. below the surface of the pit are given in Table 2. These tables present a general picture of the environmental conditions existing at the pit. It will be seen that throughout the period indicated the water has maintained a fairly constant salinity, although slight variations occur depending on the rainfall and on the amount of evaporation which takes place.

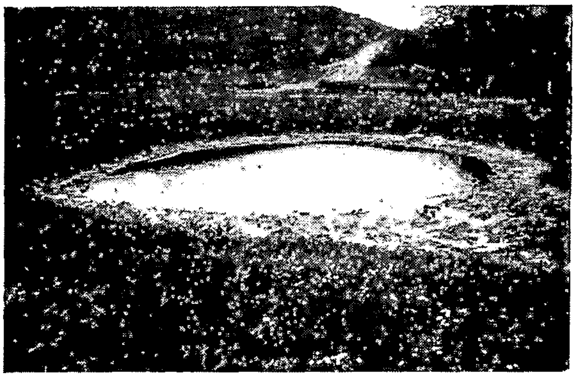

Fig. 1. THE BRINE-PIT, MALPAS.

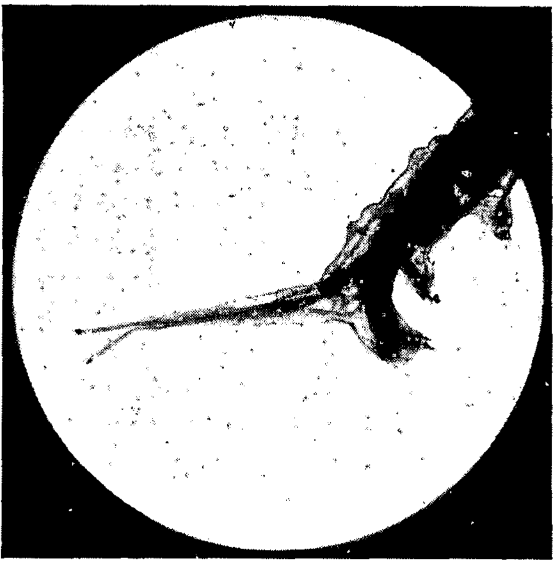

Fig. 2. LARVA OF *Ephydra riparia*, SHOWING RETRACTABLE SPIRACLES AND HOOKED SEGMENT. × 12.

The following insects have been identified from the pit:

Ephydra riparia Fallén (Diptera) is the predominating insect breeding in the pit and it occurs in very large numbers. The larva is remarkable for its interesting forked tail which carries two retractable spiracles (see accompanying photograph). In addition, it possesses a curious hooked segment, on the back near the end of the abdomen, with which it attaches itself to pieces of twig and similar objects at the time of pupation. *Ephydra riparia* belongs to the family Ephydridæ, a group of insects which appears to be particularly well adapted to life in a variety of unusual habitats. Carpenter[4] states that all species of Ephydra are capable of living in high concentrations of salt. Several species have been recorded by Thorpe[5] from brackish pools on the Sussex coast. It is interesting to note also that the petroleum pools of California are inhabited by the larva of a fly described by Thorpe[6] as a member of this family.

The specimens of *Ephydra riparia* which have been collected from Malpas brine-pit were highly parasitized by a small chalcid (Hymenoptera) belonging to the family Pteromalidæ. Many of the species of this group are at present undetermined and in consequence this parasite unfortunately remains unidentified.

Nemotelus notatus Zett. (Stratiomyiidæ) is another dipteron recorded breeding in fairly large numbers in the shallow water around the pit edge. The larva, when not crawling over the mud, has a curious habit of remaining submerged in shallow pools with a bubble of air attached to its posterior spiracles. Larvæ, pupæ and perfect insects of Nemotelus have been collected from time to time. Thorpe[5] records a species of Nemotelus from the Sussex coast.

Pupæ of the dipteron *Atissa pygmæa* Haliday were first observed at the pit on August 31, 1941. Only one perfect insect, however, emerged on September 1, 1941, from those pupæ which were collected. *Atissa pygmæa* was seen on frequent occasions during later visits to the pit, but it was never found in any great numbers.

From the observations here recorded it is interesting to note that the insects found in such an unpromising environment are all members of the Diptera. In this connexion it is perhaps well to repeat the statement made by Thorpe[7] that "the Diptera are not only able to support life in media of an osmotic pressure that is rapidly fatal to most other insects, but that they have also a greater power of adaptation to changes in concentration than have other orders".

In concluding this brief account of the insects inhabiting the brine-pit, mention should perhaps be made of those insects which from time to time have been discovered in the pit water but do not actually breed in the brine. On several occasions the hemipteron Corixa (species undetermined) was observed to visit the pit and swim for short periods in the water. On August 31, 1941, the beetle *Ilybius fuliginosus* F. was captured while swimming in the water. On June 21, 1942, an unidentified Hydrobius larva was taken when collecting water samples.

It is a pleasure to record here my acknowledgement of the assistance given by Mr. Riley, Mr. Coe and Mr. Donisthorpe of the British Museum, and of Mr. H. Britten of Manchester, in the identification of the insects found. I wish also to thank Mrs. Kay of Brine-pits Farm, Malpas, for permission granted to visit the pit; and finally to my wife for help in collecting.

[1] Sherlock, Mem. Geol. Survey, Mineral Resources of Great Britain, Rocksalt and Brine, 18, 54 (1921).

[2] Ormerod, G. W., *Quart. J. Geol. Soc.*, 4, 269 (1848).

[3] Ward, H. B., and Whipple, G. C., "Fresh-water Biology", 80 (1918).

[4] Carpenter, K. E., "Life in Inland Waters", 228 (1928).

[5] Thorpe, W. H., *Trans. S.E. Union Sci. Soc.*, 27–34 (1927).

[6] Thorpe, W. H., *Trans. Entom. Soc. Lond.*, 78, 331 (1930).

[7] Thorpe, W. H., *The Pan-Pacific Entomologist*, 7, 145 (1931).

WAR-TIME TRANSPORT IN GREAT BRITAIN

THE Fifteenth Report of the Select Committee on National Expenditure demonstrates the vital importance of transport to the war effort of Great Britain. That bad transport is one of the main causes of absenteeism and lost time in production has been emphasized from time to time in the Select Committee's earlier reports, and the evidence received during the last six months led the Committee to make a special investigation into this problem from the side of the Ministry of War Transport and the transport undertakings. While this aspect of the problem is fairly generally appreciated, it is intimately if not inseparably linked with that of passenger transport generally, and the full extent of the repercussions of the rubber and petrol situation are very far from being realized by the general public.

The evidence submitted to the Select Committee indicates that there are few, if any, services running which are not essential. The recent restrictions on the use of motor-cars in Great Britain render buses more than ever necessary for meeting the needs of the general public. Even in non-industrial areas, there is already a shortage, and there, as elsewhere, intending passengers are frequently left behind. The priority system is only partly effective in securing the transport of industrial workers. It is open to abuse, and the practical impossibility of distinguishing between essential and non-essential passengers is one of the first factors in the situation to which regard must be paid.

The second factor, which is by no means fully recognized, is the effect which transport restrictions have already had on industrial efficiency. There is a serious handicap, for example, on management, because it is no longer possible to choose the quickest and most efficient means of transport. Economy in petrol often means waste in man-hours. Moreover, not only is output affected in the factories if workers and management cannot arrive in time but also, as the Select Committee points out, the morale of the country will be affected if the housewife cannot do her shopping or if her child cannot get to and from school. It might well be added that workers in the larger towns, with their longer hours in a heavily polluted atmosphere, will suffer in health and their work in efficiency if transport restrictions deprive them entirely of access to fresh air and the countryside. No long-term policy of planning the war, such as we should now be pursuing, can safely disregard such considerations, and the severer the limitations of transport the more essential it becomes to plan their use to the maximum extent.

Transport, in fact, occupies a key place not only in the production of munitions, but also in the daily life of every man, woman and child in Great Britain. The vital importance of transport must be kept constantly in mind when questions of priority of labour and materials are decided. Indeed, the Select Committee is not merely concerned with the fair and efficient use of existing facilities; it also gives frank warning that it may well be essential to increase those facilities, and reference is made in particular to provision for the manufacture of buses and spare parts and for the supply of fuel and tyres.

What emerges from this survey is the importance of securing full co-operation between the transport services themselves and the general public which uses those services. One of the major difficulties is the labour shortage, which is aggravated by a high percentage of absenteeism among women workers, and the Ministry is criticized for its neglect to make any serious effort to ascertain the causes of such absenteeism.

Many of the Committee's suggestions are on points of practical detail. In regard to the difficult question of staggering hours in shops or factories, it recommends the establishment of local transport consultative committees in all areas and the introduction of schemes for internal or general staggering of factory hours. When such schemes are being worked out, the factories affected should be grouped roughly according to the priority of their products, so that some attempt may be made to allot the best time to the most important factories. Regional commissioners in all regions should make orders enforcing the early closing of shops in the central shopping sites of large cities, so that both shop-workers and customers can be got home before the rush of factory workers begins, and employers should, where necessary, make arrangements that their employees get reasonable shopping facilities during these restricted times. Similarly, it is recommended that except in emergency, factory hours should not be altered without first considering the transport problems involved, and the local transport consultative committees should be fully used for such purposes.

If, however, the public themselves are to help to improve the transport services of Great Britain, much greater publicity must be given to the reasons for transport difficulties. "Transport goes to War", recently issued by the Ministry of Information, makes a beginning although the emphasis is rather excessively on the blitz conditions and effects : what is wanted is something to grip the public imagination and secure their support and sympathy under everyday war-time conditions. Moreover, any appeal for the co-operation of the public, such as the Select Committee suggests, must be based not merely on a fuller understanding of the difficulties of the transport services themselves, but also on a sympathetic appreciation of the position and difficulties of the travelling public. The importance of diverting more traffic from the roads to the railways is stressed, and it is recommended that where adequate railway facilities are available for any particular factory or group of factories, special bus facilities should not be provided. Similarly, the natural tendency for people to rush for the last bus which gets them to their work at the right time requires correction by individual response, but apart from an examination by the Ministry of Labour of the possibility of reducing cross-travelling between one town and another by directing workers to places nearer their homes, it may well be doubted whether there is much unnecessary travelling by train on the part of the general public, at least over distances of any extent. It is clear from this report that the point has been reached, if not passed, when a further reduction in travelling facilities, whether by bus or rail, is likely to be a false economy, and to impair the war effort to an extent more rather than less serious, because the waste of time, of labour or of health that results may be indirect and cumulative rather than immediately obvious.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, November 21

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 2.30 p.m.—Symposium on "Industrial Radiography".

Monday, November 23

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. C. Pallot : "Some Aspects of Insulation", 1 : "Thermal Insulation at Medium Temperatures—The Insulation of Pipes and Structures" (Cantor Lectures, 1).

BRITISH COUNCIL, ROYAL ASIATIC SOCIETY, EAST INDIA ASSOCIATION AND THE INDIA SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Mr. Laurence Binyon : Fourth Centenary of the Mughal Akbar.

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Kodachrome Film : "Halifax to Victoria B.C." ; Commentary by Mr. C. W. Stokes.

Tuesday, November 24

CHADWICK PUBLIC LECTURE (in the Sir Edward Meyerstein Lecture Theatre, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1), at 2.30 p.m.—Sir Arthur MacNalty, K.C.B. : "The Prevention of Tuberculosis in Peace and War".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. J. C. Drummond : "The History of our More Important Foods", (i) Bread.*

INSTITUTION OF CIVIL ENGINEERS (ROAD ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. H. D. Markwick and Mr. H. S. Keep : "The Construction of Bases for Roads and Aerodromes using Local Aggregates and Soils".

ASSOCIATION OF SCIENTIFIC WORKERS (at the Royal Photographic Society, 16 Princes Gate, South Kensington, London, S.W.7), at 6.30 p.m.—Projection of the Cine Films entered for the Exhibition of "Photography in Science and Industry".

Wednesday, November 25

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Inst tution, Albemarle Street, London, W.1), at 3 p.m.—Mr. G. T. Winch "Photo Cells and their Applications".

Friday, November 27

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), a 5 p.m.—Mr. Frank Twyman, F.R.S. : "Interferometry in the Optica Workshop".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDER (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne) at 6 p.m.—Mr. R. C. Thompson and Mr. Harry Hunter : "The Britis Merchant Shipbuilding Programme in North America, 1940–42' (Andrew Laing Lecture).

Saturday, November 28

ROYAL PHOTOGRAPHIC SOCIETY (at 16 Princes Gate, South Kensington, London, S.W.7), at 3 p.m.—Dr. S. O. Rawling : "Sensitometry since Hurter and Driffield" (Hurter and Driffield Memoria Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on o before the dates mentioned :

LECTURER IN ENGINEERING SUBJECTS—The Principal, Kingsto Technical College, Kingston, Surrey (November 28).

VISITING MATHEMATICS LECTURER—The Principal, Froebel Educational Institute, Knebworth House, Knebworth, Herts (December 1)

LECTURER IN MECHANICAL ENGINEERING at the Rugby College o Technology and Arts—Mr. P. I. Kitchen, Organizer of Furthe Education, Rugby (December 2).

INSTRUCTOR IN BEEKEEPING—The Education Officer, County Hall, Wakefield (December 14).

REGIUS PROFESSOR OF GEOLOGY at Edinburgh University—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (January 11).

ASSISTANT TECHNICIAN IN THE PATHOLOGICAL DEPARTMENT—The Superintendent, Grimsby and District General Hospital, Grimsby.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 13, No. 4, March, 1942. Compiled by Agnes Elizabeth Glennie, assisted by Catherine Alexander. Pp. iv+233–315. (London : H.M. Stationery Office.) 4*s*. 6*d*. net. [810

Agricultural Research Institute of Northern Ireland. Fifteenth Annual Report, 1941–42. Pp. 22. (Hillsborough, Co. Down : Agricultural Research Institute of Northern Ireland.) [810

Philosophical Transactions of the Royal Society of London. Series B : Biological Sciences. Vol. 231, No. 580 : The Reproductive Cycles of the British and Continental Races of the Starling. By Dr. W. S. Bullough. Pp. 165–246+plates 12–21. 21*s*. 6*d*. Vol. 231, No. 581 : The Structure and Function of the Mouth-parts, Rostrum and Foregut of the Weevil *Calandra granaria* L. By Dr. R. Rennell. Pp. 247–291. 7*s*. (London : Cambridge University Press.) [910

Proceedings of the Royal Society of Edinburgh, Series B : Biology. Vol. 61, Part 3, No. 24 : The Occurrence of Endodermis in Leguminous Root Nodules and its Effect upon Nodule Function. By Helen L. Frazer. Pp. 328–343. 1*s*. 3*d*. Vol. 61, Part 3, No. 25 : Growth Stages in the Ammonite *Promicroceras marstonense* Spath. By Dr. Ethel D. Currie. Pp. 344–367. 2*s*. Vol. 61, Part 4, No. 26 : The Induction of Pregnancy in the Golden Hamster during the Breeding Pause. By Dr. O. Peczenik. Pp. 368–374. 6*d*. (Edinburgh and London : Oliver and Boyd.) [910

Sir Robert Kane, First President of Queen's College, Cork : a Pioneer in Science, Industry and Commerce. By D. O. Raghallaigh. Pp. 43. (Cork : Cork University Press.) 2*s*. net. [1210

Other Countries

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ANGLO-AMERICAN RELATIONS IN RECONSTRUCTION

THERE can be few who would not agree as to the importance of intimate co-operation between the United States and Great Britain both in winning the war and in winning the peace, though there are clearly some who are dubious as to the feasibility or durability of that co-operation. The agreement between Great Britain and the United States signed last February, and the exchange of notes during September on the principles applying to mutual aid and to reciprocal aid, set forth some of the ways and means by which this essential co-operation may be made effective.

As Mr. Harold Butler has pointed out in an article in *Agenda*, written before he left for Washington to take charge of British information services there, the far-reaching importance of these latter documents has scarcely been generally realized. In particular, the enumeration in Article 7 of the Agreement of February 23 of the principles upon which a settlement of the Lease-Lend account is ultimately to be concluded, which is the essential part of the agreement, has been commonly overlooked. The subsequent exchange of notes detailing the terms on which war supplies and services are to be exchanged, carrying the lease-lend policy a stage further, tends to divert attention yet more from these principles. Yet it is all to the good that this latter document should make it so plain that lease-lend supplies have long ceased to be a one-way traffic eastwards across the Atlantic. There has been considerable exchange of scientific information, but it is to be regretted that the censorship in the United States has operated in such a way as to delay or prevent the transmission abroad of a journal such as *Science* and of individual articles in other scientific journals, thereby impeding the flow of information.

There can be no question as to the soundness of laying down so far as possible the principles upon which reciprocal aid is applied in the prosecution of the War. That is one of the surest methods of eliminating misunderstandings or any friction which may be engendered by arbitrary or injudicious handling either of the censorship or other matters. We may count on Mr. Butler to continue in Washington that invaluable work of interpretation and exposition to which he addressed himself in Great Britain.

The principles upon which a final settlement is to be concluded may be briefly summarized as follows: First, the terms "shall be such as not to burden commerce between the two countries". Secondly, their aim is not merely the promotion of Anglo-American trade, but also "the betterment of world-wide economic relations". Thirdly, the methods by which this goal is to be sought are: (*a*) through "the expansion, by appropriate international and domestic measures, of production, employment, and the exchange and consumption of goods"; (*b*) through "the elimination of all forms of discriminating treatment in international commerce"; and (*c*) through "the reduction of tariffs and other trade barriers". Fourthly, participation in agreements to this end shall be open to "all other countries of like mind".

Mr. Butler considers that this agreed statement of aims may prove a decisive factor in the development of Anglo-American relations. Agreement in the view that the key to a comprehensive economic settlement is to be sought in an expansionist policy immensely facilitates the discussion of the thorny problems which will have to be solved. A big step has been taken towards assuring the co-operation of the two countries during the difficult period of international reconstruction. Great Britain and the United States are pledged to a joint effort in building a new world economy. The major responsibility in European restoration must indeed fall on Great Britain, but we cannot give the lead and secure the co-operation of our allies, and not least of the Soviet Union, without thinking on an international scale and creating international machinery.

These agreements pledging Britain and the United States to work together with a common plan and a common ideal provide us with the means of forging a powerful weapon in the war of ideals. As the outline of a better society begins to take shape, holding the promise not only of national freedom and individual liberty, but also of greater social security based on economic prosperity, the United Nations will fight with redoubled energy. The Anglo-American agreements may well be developed into the programme of a new international order, adding fresh driving force to the faith of the United Nations ; and the remarkable series of speeches in recent months by leading men of the American administration, from the President downwards, shows the extent to which a new idealism has already gripped the minds not only of economists, sociologists and scholars, but also of statesmen. Mr. Henry Wallace's thought of "the century of the common man" rather than of "the American century" has clearly caught the imagination on both sides of the Atlantic.

These speeches of Mr. Wallace, Mr. Sumner Welles and Mr. Cordell Hull are of importance as indicating the beliefs upon which the American conception of a new order rests. Mr. Hull indeed has laid down the principles of a broad programme of world economic reconstruction in direct opposition to the programme outlined by the Nazis, and it pre-supposes an attempt to combine economic liberty with economic order. He repudiates excessive trade restrictions or discrimination in international commercial relations. Raw materials must be available to all nations without discrimination. International agreements regulating the supply of commodities must be handled so as to protect fully the interests of the consuming countries and their peoples. The institutions and arrangements of international finance must be set up so that they lend aid to the essential enterprises and continuous development of all countries, and promote the payment through processes of trade consonant with the welfare of all countries.

This programme and these principles have far-reaching implications, including the condemnation of past trade policies of Great Britain and of the United States. It will be noted how far in harmony they are with the new colonial development policy which has been initiated since the outbreak of war, and with the outlook on this topic of Lord Hailey and others in Great Britain. What must be realized, however, is the importance of the American approach and the American proposals being clearly understood in Great Britain. As Mr. Butler says truly, the active prosecution of British thought on reconstruction is a war-issue as well as a peace-issue.

Neither in the United States nor in Britain, in fact, can our thought about reconstruction, whether internal or international, be confined to purely national considerations or calculations. Naturally enough, much more thinking on post-war problems has been done during the last two years in the United States, but the concern which Lord Reith and, more recently, Lord Latham have expressed in the House of Lords at Government delay in dealing with the findings of the Scott and Uthwatt Committees, and in providing the essential machinery for planning, is not entirely a domestic issue. It inspires criticism abroad which may not always be fair, but such dilatoriness towards planning is a handicap to good Anglo-American relations, as is very clear from Mr. Butler's article.

The debate in the House of Lords on November 18 and 19 arose out of a motion by Lord Latham urging the Government to introduce without delay the legislation necessary to make possible preparatory steps, so that actual planning and reconstruction may begin as soon as hostilities cease, and referred only to reconstruction in Great Britain. It produced statements from Lord Portal, Minister of Works and Planning, and the Lord Chancellor, respectively, the tenor of which was to show that the Government is actively engaged on the many intricate problems involved, while Sir Stafford Cripps in the House of Commons promised legislation during the present session. Clearly we must put our own house in order before we can approach other countries.

In this connexion the report of the U.S. National Resources Planning Board on National Resources Development in 1942 should not be without interest in Great Britain. Its review of public works planning is concerned with particular programmes in the United States, but the functional development policies described in Part III of the document are of wider interest. They show how the problems of industrial location, of transport, of the utilization of special skills, of urban conservation and development, of planning for social security, and post-war planning for children and youth, are being faced in the United States.

The introduction and first part of this report, however, are of special interest as indicating the approach of the United States to these problems. The clarification of our objectives for the onward march of freedom-loving people is seen as an essential part of the war-effort. The report looks forward to securing, through planning and co-operative action, a greater freedom for the American people, and the introduction suggests that any translation of freedom into modern terms applicable to the United States must include : (1) the right to work, usefully and creatively, through the productive years ; (2) the right to fair pay, adequate to command the necessities and amenities of life in exchange for work, ideas, thrift and other socially valuable service ; (3) the right to adequate food, clothing, shelter and medical care ; (4) the right to security, with freedom from fear of old age, want, dependency, sickness, unemployment, and accident ; (5) the right to live in a system of free enterprise, free from compulsory labour, irresponsible private power, arbitrary public authority and unregulated monopolies ; (6) the right to come and go, to speak or to be silent, free from the spyings of secret political police ; (7) the right to equality before the law, with equal access to justice ; (8) the right to education for work, for citizenship, and for personal growth and happiness ; and (9) the right to rest, recreation and adventure ; the opportunity to enjoy life and to take part in an advancing civilization.

The central problem is one of freedom and the distribution of abundance, so that there may be no unemployment while there are adequate resources and men ready to work and in need of food, clothing and shelter. The obligations which go with such rights are also recognized. The preliminary objectives are visualized as planning for full employment without demanding hours in excess of forty per week or fifty weeks in the year, using to the utmost a system of modified free enterprise. The planning of demobilization and the stimulation of planning by private enterprise, including the study of the consumer market, of industrial location and of management, the relation of Government to private enterprise, schemes of public works, transport and land development, and the extension of such services as health, nutrition and medical care, all find a place in the programme, and the section on international planning indicates that American thought is well prepared for the responsibilities in European reconstruction outlined in a recent pamphlet issued by the Royal Institute of International Affairs.

That thought on reconstruction in Great Britain and in the United States should be on such similar lines is not surprising. It was an Englishman who put the case for the Colonies before his countrymen in the House of Commons better than any of their spokesmen did before the Colonists themselves. The passage of more than a century and a half has not weakened the strength of the heritage and ideals which the Anglo-Saxon democracies share. The ordeal of war has rather intensified their meaning, and Burke's words, like Jefferson's declaration, come down to us with fresh meaning and assurance of the grandeur of that common heritage. The mixing up of the two great democracies under the strain of war, the perils shared and the new comradeship in arms and in production, should assuredly lead to a fuller understanding that will promote accord and comradeship in the no less searching tasks that lie ahead in building and maintaining the peace. It is the duty of every citizen, of scientific workers no less than others, to see that every opportunity of fuller understanding is grasped and that the obstacles to co-operation, whether in peace or war, like the misunderstandings which lead to friction, are firmly and persistently swept away.

TIDES : THEORY AND PREDICTION

Admiralty Manual of Tides

By Dr. A. T. Doodson and Comdr. H. D. Warburg. Pp. xii+270. (London : H.M. Stationery Office, 1941.) 12*s.* 6*d.* net.

THE numerous and important developments in our knowledge of the tides that have been made in recent years are largely hidden away in technical journals. There has been but little written for those who wish to know something of the tides and their causes without working through the heavy mathematics which usually surrounds the subject. G. H. Darwin, in his "Tides and Kindred Phenomena", published in 1898, gave a clear non-mathematical account of the subject as it was then. Public interest in the theory of the tides was shown by the demand for further editions in Great Britain and by its translation into several foreign languages. Warburg's "Tides and Tidal Streams" (1922) was intended for seamen and for those who require a professional knowledge of the tides; but it contains a description of the chief tidal features in a form suitable for the general reader. Marmer's "The Tide" (1926) is a simple and readable account of the subject and includes references to the more recent work. In addition, many text-books of geography and allied subjects have devoted a chapter to a more or less sketchy account of the tides and their causes. But there is clearly room for a book, which, while it does not avoid mathematics altogether, yet steers a middle course between the formal treatise and the popular account for the non-scientific reader, and also incorporates the developments of the last thirty years. Such a book is the "Admiralty Manual of Tides".

The book is written with a dual purpose. It is first to give a scientific account of the tides for the use of hydrographic surveyors and naval officers, and to give it in such a form that it may be readily applied. For such, it is necessary to include some mathematics, though not more than is covered by elementary algebra and trigonometry. Secondly, for those who wish to avoid mathematics, there is a connected account, based principally upon geometrical diagrams, that is complete in itself. The mathematical paragraphs are marked with asterisks and can be skipped without vitiating the main argument. The diagrams are numerous and ingenious, and no pains have been spared to make clear the various points.

There are two main lines of investigation in tidal science. The first is practical in its outlook and intention. In it, series of observations of tidal motions are made for each port under consideration. These observations are reduced to suitable form, and from this, tide tables for the future are deduced. The most successful method of reduction is that proposed by Kelvin, the harmonic analysis of the tide into its fundamental components. Recently, this method has been much improved in form and has been extended to include shallow-water and other components which formerly impaired the accuracy of the predictions. Little theory enters into this part of the subject, except the broad principle that component periodic forces in general produce oscillations of corresponding periods in a dynamical system, though with possibly different amplitudes and phases. The method has achieved great success, as is seen in the remarkable degree of accuracy of current tide tables.

The second aspect of investigation is more ambitious and much less successful. In its ideal form it attempts, by use of the law of gravitation, and the laws of fluid motion, together with a knowledge of the contours of the ocean beds, to predict what the tides should be, without making any use of observations. In this it resembles the planetary theory of dynamical astronomy. Needless to say, the contours of the ocean beds being what they are, the problem in its general form seems impossible to solve. Some progress has, however, been made by substituting oceans of simple geometrical forms; and the tidal features of oceans bounded by vertical cliffs along meridians of longitude or parallels of latitude have been deduced. A further simplification, suitable to the cases of seas of small area, is to neglect the sphericity of the earth. Some cases of this type have been solved, giving results of great interest.

Both aspects of tidal investigation are treated in this book. The first part deals with the methods of recording the tides, and the methods old and new, non-harmonic and harmonic, of tidal prediction. While the complete processes of harmonic analysis and synthesis are necessarily used in the formation of published tide tables, it is frequently necessary to determine the high and low tides for a particular day, or the tides at various times of a day, when tide tables are not available. The authors of this book have devised a method of prediction, of the greatest simplicity and of considerable accuracy, which can be used whenever the harmonic constants M_2, S_2, K_1, O_1 appropriate to the place are available. By a judicious system of approximations based partly upon the equilibrium theory and partly upon experience, and by suitably prepared reference tables, other components than those mentioned are incorporated in the result. Arrangements are also made to include shallow-water components wherever these are significant. This method, though incorporating the mixed semi-diurnal and diurnal tides, involves very little computation. The actual work can after practice be carried through in a few minutes. Its success may be judged from the following results:

For Dover, March 25, 1936,

High water	Predicted	0h. 9m., 20·4 ft.;	12h. 28m., 20·4 ft.
	Observed	0h. 4m., 20·2 ft.;	12h. 26m., 19·8 ft.
Low water	Predicted	7h. 34m., —1·6 ft.;	19h. 53m., —1·6 ft.
	Observed	7h. 46m., —1·4 ft.;	19h. 58m., —1·4 ft.

To those who know the difficulties of the subject, these figures require no comment. The authors have given to the process the name "Admiralty Method". It was originally published in 1936, but does not seem to have received the attention it deserves.

The second part of the book deals largely with the theory of waves as applied to the tides. In this connexion the rotation of the earth is of importance, and a full account is given of Kelvin waves and combinations of them producing amphidromic systems. The application of such systems together with essential tidal observations has resulted in the successful tracing of the progress of the semi-diurnal tide in the seas about Great Britain.

The history of co-tidal maps of the British seas is interesting. The first map, due to Whewell (1836), showed a wave in the North Sea travelling down the east coast of Britain and northward up the Dutch coast. In the Flemish Bight he actually exhibited an amphidromic system, though this was not accepted as a possibility at the time. Airy in 1845 eliminated this amphidromic system and replaced it by tidal waves crossing each other in a somewhat inexplicable manner. In the English Channel, too, Airy insisted that the co-tidal lines must be curved, the speed of the waves being supposed greater in mid-channel than along the coasts, a theory that was later proved impossible. In 1904 Harris produced co-tidal maps showing an entirely different form of the co-tidal lines in the English Channel and the Irish Sea. These show degenerate amphidromic systems very close to the forms now accepted. Harris also found an amphidromic point off the south of Norway in addition to that in the Flemish Bight. Tizard's chart published in "Tides and Tidal Streams" (1909) represents an amphidromic system in the Flemish Bight, but rather remarkably makes it appear to require two tidal periods for the wave to circulate about the no-tide point instead of one! A further improvement was made by Sterneck in 1920, who got still nearer to the correct forms.

In preparing all these charts the authors mentioned above relied on coastal observations alone and ignored the extensive knowledge of the tidal streams which then existed. From 1924 onward, Proudman, Doodson and Corkan, utilizing all available observational data, and checking them against the simple formula which connects the tidal current with the surface gradient, have produced charts of the complete system of the semi-diurnal tide in the British coastal waters. This is now published as an Admiralty chart, and is probably the first of its kind to be produced in which speculation plays no part and of which all available evidence demonstrates the correctness.

The explanation of the occurrence of the three amphidromic systems which appear in the co-tidal chart of the North Sea can be made intelligible without recourse to any form of mathematics. This the series of seven diagrams in Chapter 25 does with great clearness.

A common theory found in nearly all text-books is that the principal tidal wave is generated in the Southern Ocean, that ocean, surrounding the globe, being considered the only place where the tide-producing forces can be completely effective. The tidal waves of the Atlantic Ocean, the Pacific Ocean and the Indian Ocean, are regarded as secondary waves derived from the Southern Ocean and not as waves produced by the tidal forces within these areas themselves. Against this view, almost seventy years ago, Ferrel, after a study of the Atlantic tides, decided that "if there were a dike extending from the Cape of Good Hope to the coast of South America, the tides of the North Atlantic Ocean would most probably be very nearly the same". The results of recent investigations show that the Atlantic tides, far from being secondary waves, are produced within that ocean itself, and that their magnitude is due to approximate resonance with a free period of oscillation. In a set of diagrams the authors show the co-tidal systems of the semi-diurnal tide in a series of oceans bounded by two meridians at different distances apart. These diagrams help to indicate the kind of tidal motion that may be expected in the Atlantic Ocean or the Pacific Ocean.

The double high water at Southampton, so important to the commercial prosperity of the port, has always been a matter for ingenious speculation. A favourite theory is that the phenomenon is due to the main tidal wave from the Atlantic reaching Southampton by two routes, one via the west and the other via the east of the Isle of Wight, the time difference of two hours being accounted for by the longer passage of the eastward route. Although this theory was certainly scotched by Airy a hundred years ago, and may have been exposed earlier, the idea still persists. Indeed only a few weeks ago it was broadcast by a member of the B.B.C. Brains' Trust as an established fact! The problem is fully discussed by the authors, and by simple analysis it is exhibited, as it really is, as the semi-diurnal tide modified by shallow-water tides. The point of interest which comes out, and which remains still a mystery, is why the shallow-water components should be so adjusted in magnitude and phase as to give exactly a double high water at Southampton, and yet a double low water at Portland.

The chapter on "Bores" is worked out on very simple lines. By use of Bernoulli's integral and the equation of continuity, it is possible easily to explain the main features of tidal bores and the conditions necessary for their existence.

Many other matters of interest might be commented upon, but enough has been said to indicate the scope and character of the book. It is a work which will have great value and influence in schools of navigation and geography, and will prove interesting reading for those who seek knowledge for its own sake. It removes many fallacies and misunderstandings which have persisted, and it presents the subject in a new and clearer light, at once interesting and correct.

G. R. GOLDSBROUGH.

AN INTRODUCTION TO ECONOMICS

The Social Framework

An Introduction to Economics. By Prof. J. R. Hicks. Pp. xii+212. (Oxford: Clarendon Press; London: Oxford University Press, 1942.) 7*s*. 6*d*. net.

A NEW way of handling elementary economics is badly wanted—a really new approach to the subject which will bring it into living connexion with contemporary realities. The traditional 'shape' of the subject, worked out during the second half of the eighteenth and the first half of the nineteenth century and thereafter modified only in detail, was the product of an age which had, except in the realms of foreign trade and public finance—and even there the data were scanty and often misleading—no statistical basis for study of the essential facts. This is not the sole explanation of the highly abstract and deductive methods which were employed by the classical economists; but it is a large part of the explanation. Their successors took over from them the apparatus they had devised, and have in the main continued to use it right up to the present time, partly because it had acquired a certain sanctity as the biblical justification of free trade and *laisser-faire*, and partly because it provided the readiest means of teaching economics as an academic subject, without too much soiling of the brain by contact with the sordid doings of the business world.

Gradually, this older body of economic teaching has been losing its hold. Some economists have been breaking more or less thoroughly away from it, and relying more and more on study of actual statistics rather than on abstract reasoning, while others, despising such studies except as occasional diversions from a higher task, have retired into the realm of mathematics and there built for themselves the most exquisite fairy castles of refined theory, with barely a rainbow road to connect them with the real world. Prof. Hicks himself has been a wanderer in this fairy kingdom; but now he has come back with a swift descent to the countries where things are actually bought and sold, and has presented us with an elementary text-book of economics considerably unlike other text-books and, for the beginner, very much easier to read and understand. It is true that he half promises a sequel, which will lead his readers back to the fairy kingdom, for which he has by no means lost his affection or his respect. But experience in actual teaching of elementary students seems to have taught him, as it might long ago have taught others, that the abstractions of the theory of value and of 'equilibrium economics' are not the most favourable ways of entry to the subject for the ordinary learner.

I think one reason why this lesson has not been more readily learnt by economists is that the abstract approach, deterrent as it is to the less clever students, does hold out high prizes to the clever. If a student has a high-class logical or mathematical brain, and enjoys logical or mathematical exercises, he can get a very long way very quickly in the fairyland of economic abstractions, without being in any degree held up by his ignorance of the real world; whereas, if he attempts a realistic approach, he is liable to be continually brought up against his lack of acquaintance with the facts he is trying to arrange into some sort of order. Prof. Hicks has tried to avoid this difficulty by eschewing entirely facts which have about them any taint of technique, with the consequence that his book says a lot about wages, profits, capital, shares, joint stock companies, and other things which anybody can understand, but very little about industry or production, save in the most general terms. Prof. Hicks would perhaps argue that such things belong to the realm of technique, or of applied economics, and not to the elements, with which alone he is concerned in the present volume; but I find the effect a little lop-sided. The question of monopoly, for example, is practically not dealt with at all, though it is surely vital.

All the same, I am in general very grateful to Prof. Hicks for what he has done. On the whole, I think he has rather overdone the simplicity, and sheered off certain subjects which he could have treated in a reasonably elementary way—notably money and the wide questions of the relations between the volume of employment and production on one hand and the distribution of income and the levels of consumption and investment on the other. Nor can I feel happy about a book on elementary economics from which the notion of 'margins' is practically absent; for though much evil has been done in the teaching of 'marginal' doctrines, the conception is one which has a necessary place in the study of real economic processes, even at a quite elementary level. These criticisms, however, are not meant to amount to a denial of the high value of what Prof. Hicks has achieved.

What has he done? He has produced a book which is well designed to serve two purposes—to keep his students interested, including his less clever students, and to send them on to study economics with a good idea of what it ought to be about and of the way in which statistics can be handled in the course of studying it. His book is, in the words of his sub-title, "an introduction *to* economics", rather than an elementary text-book *of* Economics—and I imagine that is what he intended it to be.

I have no space to deal with particular points, save in a sentence or two, though there are many on which I should like to comment. I do not like his unargued acceptance of economics as a 'science', or share his view of the progress which it has made. I think he treats the population problem too much in terms of mere quantity, and too little in terms of quality. I think he uses the word 'profits' ambiguously, as so many economists do. His equation of consumers or customers with employers seems to me misleading; and I think his omission of most of the problems of monopoly vitiates his treatment of the questions of capital ownership and control, which is in other respects refreshingly realistic. I could add many similar points of criticism; but, unexplained, they would serve no useful purpose, and would convey a misleadingly hostile impression of what I regard as a very useful and timely little book.

G. D. H. COLE.

A DYER IMPARTS HIS KNOWLEDGE

Dyeing with Coal-Tar Dyestuffs

The Principles Involved and the Methods Employed. By C. M. Whittaker and C. C. Wilcock. Fourth edition. Pp. vii+371+10 plates. (London: Baillière, Tindall and Cox, 1942.) 16*s*.

THE term 'chemical industries' in its wider significance comprises all those manufactures in which the formation of the products sold depends on chemical interactions and is certainly not confined to the manufacture of chemicals. All these industries, in reality based on chemicals, though still prone to pay lip service to the 'arts and practice' of their calling, are having to admit the scientific man into their management. It was Davy who wrote in 1802 that the arts of bleaching and dyeing, which the habits and fashions of society have made important, are purely chemical.

Since then a number of men with honoured names have brought chemistry into the dye house, writing books whereby their knowledge might be imparted to others. The latest of these books is from the pen of C. M. Whittaker, who for forty years has done as much as anybody both in discovery and in the application of his chemical knowledge to a very ancient art. Incisive in speech, he writes clearly and to the point, and he and Mr. C. C. Wilcock are to be congratulated on a most useful production.

This is a fourth edition; it appears only four years after the third, a fact which may be taken to mean renewed interest in dyeing under war conditions. One of the sales methods adopted by continental competitors was to give much assistance in the dye house of a customer conditional on the purchase of foreign dyes. The acceptance of this help has proved a short-sighted policy.

Dyeing in the old days used to be a question of cotton, silk and wool. Now new fibres of several kinds have arrived, which may be the forerunners of a legion, and the dyer is faced with new responsibilities. The production of Rayon yarn and staple fibre now amounts to about one sixth of that of cotton, though the increase has not been at the expense of cotton or wool. The production of silk has fallen and may well continue to do so.

Eight of the chapters deal with specific coal-tar dyestuffs, in the divisions which are customary. New sections deal with the structure and identification of textile fibres, with the preparation of textile materials for dyeing and with the principles of dyeing machinery. Some of the older sections have been re-written and all have been brought up to date, for the subject of dyeing is anything but static.

Dyeing in Great Britain has a great post-war future. There will be millions of new homes to be furnished and there is both opportunity and urge to make the textiles colourful and of good design. Let us hope the industry will be made an all-British one, free from Continental influence; with leaders such as Whittaker available there should be no difficulty.

E. F. ARMSTRONG.

WAR-TIME FARMING IN BRITAIN

Farming Handbook

By Sir E. J. Russell, Dr. H. D. Kay, Dr. W. G. Ogg, B. T. P. Barker, Malcolm Messer, Geoffrey Browne, F. H. Garner, J. A. McMillan, T. Nellist Wilks, Dr. E. Holmes, W. R. Orrell, and other Experts. Pp. iv+220+52 plates. (Norwich: Jarrold and Sons, Ltd., 1942.) 5*s*.

CONDITIONS under which farmers have to carry on their business have changed so much in the last three years that a collection of articles by well-known specialists on the most important technical aspects of agriculture is particularly welcome. The approach to the various problems of production has been influenced by the complete change in the situation in Great Britain as regards the proportion of land under the plough, the very small amount of purchased feeding stuffs available, control of the purchase and use of fertilizers, etc. An authoritative handbook of this kind helps efficient farming by presenting essential and up-to-date information drawn not only from the results of experiments and research but also from the experience of war-time farming.

The first contribution is by Sir John Russell, on crop production in war-time. This brings together the results of many experiments on different crops, and discusses a few of the more important pests and diseases of cereal crops. The article is particularly useful, written, as it is, by a scientific man with a keen sense of the significant; there is in it no material of purely academic interest. Among other contributions are articles on dairy farming in war-time, by Prof. H. D. Kay, and feeding farm livestock in war-time, by F. H. Garner, which provide the reader with the necessary information for the successful management and feeding of the dairy herd, and of farm livestock in general. The former includes a discussion on the technique of milk production, and on disease in relation to production. Other articles, also rich in practical advice, are concerned with fertilizers, fruit growing, land reclamation, farm machinery, etc.

All the contributions deserve mention, but this is impossible within the space of a short notice. Practical men, potato growers in particular, may be forgiven for starting the book by reading the contribution on potato cultivation on a large commercial scale, by G. F. Young, manager of Messrs. Smith's Potato Crisps farms; it is good, and savours of a wealth of experience gained by an observant grower.

The book is illustrated, and is well printed on good paper. It can be recommended to farmers, scientific men, and to technical and other members of War Agricultural Committees.

Torch and Crucible

The Life and Death of Antoine Lavoisier. By Sidney J. French. Pp. x+285. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1941.) 21*s.* 6*d.* net.

LAVOISIER, founder of modern chemistry, and one of France's greatest sons, has formed the subject of many biographical studies. Some of these have dealt mainly with his scientific achievements, others with his place in history. Mr. French has been very successful in his attempt to give a complete synthesis of this versatile and commanding figure in pre-Revolution France. Here we see Lavoisier not only as the inspired creator of a new chemistry, but also as one whose "active mind coordinated scientific genius, business efficiency, political vision, and public benefaction in a perfect harmony of tone". His domestic, social and political backgrounds are clearly outlined in the course of an easy, attractive—and, at times, dramatic—narrative; so are his relationships with Priestley, Cavendish (who is wrongly mentioned on p. 146 as "Lord" Henry Cavendish), and a galaxy of scientific men of his day.

The general reader should extract almost as much pleasure from this book as his scientific friends, and that is saying a great deal. Effective humanistic studies of the great figures of science are rare, and we owe a debt of gratitude to such writers as Mr. French. The appearance of this new study is a welcome herald of next year's bicentenary of Lavoisier's birth. The production of the book is sumptuous. The sole illustration is a charming reproduction on the paper jacket of David's painting of M. and Mme. Lavoisier. Unfortunately, the high price may prevent the book from attaining the wide circulation that it deserves among the lay public. J. R.

Magic and Natural Science in German Baroque Literature

A Study in the Prose Forms of the Later Seventeenth Century. By Frederick Herbert Wagman. (Columbia University Germanic Studies, No. 13.) Pp. vii+178. (New York: Columbia University Press; London: Oxford University Press, 1942.) 15*s.* 6*d.* net.

IN this richly documented work, the author shows to what extent the German intellectual laity were influenced by contemporary scientific men, such as Galileo, Kepler, Bacon, Pascal and Jungius. The principal lay writers considered are Daniel Casper von Lohenstein, Georg Philipp Harsdörfer, the author of forty volumes of poetry and prose, Eberhard Werner Happel, the author of twenty "gallant" novels and a five-volume work on the wonders of the world, Erasmus Francisci, the compiler of compendia of curiosities, Christian Weise, an opponent of the scholasticism of German universities, Johann Riemer, Johann Beer, the author of eighteen novels and one of the most gifted writers of the seventeenth century, and Johann Christoph Grimmelshausen, the author of "Simplicissimus" and representative of Christian asceticism. The influence of the scientific writers of the age appears to have had various effects. In the first place there was a waning of medieval belief in miraculous intervention in Nature and the theological interpretation of phenomena, although remnants of occult lore were still present. Secondly, a dominant rationalistic tendency was shown by the belief that Nature is autonomous in its control over mundane and sidereal phenomena and free from intervention by either divine or diabolic agency.

Ethnographic Bibliography of North America

By George Peter Murdock. (Yale Anthropological Studies, Vol. 1.) Pp. xvi+168. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1941.) 12*s.* net.

THIS first number of a new series of anthropological studies sets a high standard for its successors. The author of the bibliography has been engaged in its compilation on and off for about twelve years and the result is comprehensive and most useful, covering as it does the aboriginal population of the whole of North America. The principle of classification by tribal groups was adopted, the norm being the "nationally self-conscious tribes of regions with some measure of political development, e.g., those of the Plains". Where this standard could not be obtained a number of tribelets or local groups on approximately the same linguistic or cultural plane were united under the name of one of them.

The difficulty of charting these divisions on a map was increased by the shifting of the tribes during three centuries, which necessitated a number of compromises. The boundaries shown are approximately those of the various groups at their first extensive contacts with Europeans, and thus they are not all valid at any single period, but represent a shifting date line.

The work is organized by areas, each containing general references followed by areal références to the tribes in alphabetical order, and comprising works on physical anthropology, linguistics and archæology, as well as the more general ethnological works. The whole contains an astonishing bulk of literature dealing exhaustively with the anthropology of the whole sub-continent. K. RISHBETH.

The Furtherance of Medical Research

By Dr. Alan Gregg. (The Terry Lectures.) Pp. x+129. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1941.) 12*s.* net.

DR. ALAN GREGG, the distinguished director for medical sciences of the Rockefeller Foundation, has presented us with a thoughtful and stimulating work in the form of three lectures devoted respectively to a description of medical research, universities and foundations in relation to such research, and the medical research worker. In the first lecture he points out that research in any field comprises a series of activities consisting in selecting, observing, recording, comparing, analysing and classifying phenomena and finally drawing suitable conclusions, each of which contributes to, but cannot be substituted for, the whole process. In the second lecture Dr. Gregg maintains that, compared with a Government's subsidizing of research, foundations can much more easily work outside national boundaries and support the demonstration of theories which are not sufficiently widely accepted to qualify for Government support. Moreover, foundations can pay larger salaries than a Government is capable of doing. The third lecture contains a sympathetic account of the uphill struggle of the young research worker.

There are two appendixes consisting respectively of an outline docket film and an outline for presenting a proposal for a capital grant for building an institute.

INTERNATIONAL SYSTEMS AND STANDARDS*

By SIR RICHARD GREGORY, Bt., F.R.S.

THE Great Exhibition of 1851, in Hyde Park, London, was the pioneer of international exhibitions, and it demonstrated the industrial resources of the nations which took part in it as well as the extent of world markets in them. The International Exhibition held in London eleven years later led to the formation of the International Working Men's Association, now known as "The International", at a great public meeting in 1864 of artisans from many countries, and thus brought conditions of labour into the economic field. In the following year an International Telegraph Convention was held to regularize systems of transmitting telegraphic signals, and in 1874 the General Postal Union was formed. These were the beginnings of international trade associations, unions and relationships. The Postal Union is the best example of organization of systems and standards on an international basis. For its service the world is the unit and there are no separate territories or boundaries.

It is necessary for manufacturers to adopt and maintain standards of measurement for their products, whether for domestic or for foreign trade. Standardization within and between industries leads to better understanding and co-operation in the common interests of the producer and the consumer. It is increasingly important for the maintenance and development of foreign trade and is the best means of ensuring fairness of exchange and facilitating industrial operations. After the War of 1914–18, one of the outstanding developments in the chief industrial countries, and perhaps more particularly in Great Britain and the United States, was that of co-operation in standardization of products of allied or related industries on a national scale.

So far back as the beginning of this century, a small group representing civil, mechanical and electrical engineering was set up in Great Britain as the British Engineering Standards Association, which was incorporated by Royal Charter in 1929 and is now the British Standards Institution. There are two kinds of standardization—one concerned with fundamental standards and units of measurement, and the other with the rather wider field of industrial simplification and uniformity. The latter involves the adoption of standard specifications of material and method in all branches of industry where they can be usefully applied ; and they are constantly being added to and revised to meet new industrial needs.

For inter-Imperial trade it is desirable to have common agreement upon standards of measurement based upon the British system of weights and measures. The British Standards Institution exists to ensure this uniformity of principles and practice of standardizing bodies in all parts of the Empire. It has also the duty of converting British standard specifications into those of other countries having standardized systems, in order to facilitate foreign trade. As, however, the tendency for many years has been towards the adoption of the metric system in new industries, and this system is already used in most countries of the world, there is every reason to believe that it will become truly international in its service and that national and Imperial standards will have to be adapted to it for purposes of world trade. In recent years the scope of the work of the Institution has been very greatly enlarged, and at the present time it covers much work on rationalization and simplification, with special reference to war-time needs in relation to materials in short supply and the use of substitutes.

The use of scientific principles as the basis of measurement came under consideration in the early days of electrical engineering. A century ago there was no settled system for the measurement and statement of electrical quantities, and all electrical measurements were merely comparisons between magnitudes of the same kind. The resistance of one conductor could be compared with that of a particular piece of wire and the electromotive force of one battery could be compared with that of another, but there were no recognized relationships between these quantities or fundamental standards to represent them. The German physicist, W. E. Weber, conceived the idea of expressing the value of any electrical quantity without reference to any quantity of the same kind, and in terms not involving any physical constants except the units of length, mass and time.

The British Association took up the subject in 1861 at the suggestion of Lord Kelvin, and the result of reports of its committee was the establishment of the coherent system now adopted everywhere in science and engineering. After much discussion and correspondence, it was decided to adopt the centimetre, the gram and the second as the primary units of length, mass and time to which the various quantities used in electrical measurements could be referred. This is the C.G.S. system, and all values of electrical quantities are expressed in these units. For practical purposes, standards of electrical resistance, current, electromotive force and power have been adopted by international conferences as particular magnitudes of the centimetre, gram and second. Germany, France, Italy and Great Britain are respectively represented in the names of these fundamental electrical units by ohm, ampere, volt (Volta) and watt.

Several years ago, Prof. G. Giorgi, of the University of Palermo, proposed a new system of electrical units based upon the metre, kilogram and second (the M.K.S. system), and the International Electrotechnical Commission recommended in 1938 that this system should be adopted in all countries. The system is in no way antagonistic to the C.G.S. system, and for instructional and practical purposes it has decided advantages in simplifying relationships between fundamental electrical, mechanical and magnetic units.

In science, and to an increasing extent in engineering, measurements are usually expressed in the international units of length, mass and time. For each of these fundamental quantities it is necessary to have a primary standard of reference. The primary standards of length and mass are kept at the International Bureau of Weights and Measures at Sèvres, near Paris. They are the International Prototype Metre and the International Prototype Kilogramme. The centimetre is 1/100 of the standard metre, and the gram 1/1000 of the standard kilogram. The standard international unit of time is one second, or the 86,400th part of the mean solar day.

With the introduction of railway systems, a standard time had to be adopted for the time-tables of trains. In Great Britain the standard time adopted was that of Greenwich; in the United States, where local times differ by several hours from one another, it was impracticable to use a single time standard for the whole country. The running of long-distance trains in times which differed greatly in different States was so confusing that a remedy had to be found; and it was produced by a Scots Canadian, Sir Sandford Fleming, in 1878. His proposal was to legalize a universal day, beginning at mean noon of Greenwich time, the hours being counted 0 hour to 24 hours. A few years later a conference held at Washington approved the adoption of a single prime meridian, and also Sir Sandford Fleming's principle of dividing the whole earth into twenty-four time zones, each separated from the next by one hour. This zone system of daily time reckoning on a uniform and universal plan has become truly international and has superseded by fixed standards the medley of prime meridians and local times which kept peoples apart and hindered the development of their common interests.

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* From an address to the Association of Special Libraries and Information Bureaux, delivered on November 7.

The division of the whole interval of day and night into twenty-four parts or hours, each of which was subdivided into parts like minutes and seconds, goes back to Babylonian times six thousand or so years ago. (The division of the angles in a circle into 60 by 60 or 360 degrees has the same origin.) The day and the night were each given a duration of twelve hours, but the lengths of the hours differed locally and with the seasons. With the introduction of clocks, it became necessary to establish a standard time interval independent of the varying lengths of the local day from one solar noon to the next. The average interval between successive noons became this standard as the mean solar day, which is the common day of civil life, and gives rise to mean solar time, or mean time. From about the end of the eighteenth century, mean time has been used in most countries instead of local solar time.

The standard time of a country or region is reckoned from a particular meridian, as it would be confusing to use a number of mean local times. Since the adoption of the zone system, standard times are referred to twenty-four meridians separated from Greenwich by a certain number of hours, with the zero hour at midnight and reckoned up to twenty-four hours, or in Great Britain up to twelve hours ante-meridian and twelve post-meridian. For practical purposes, the rotation of the earth upon its axis is invariable, and so is that of the second, or 1/86,400 part of a day, derived indirectly from it. The unit measure of time is, therefore, the same in all countries.

Various standards of measurement of length and mass (or weight) are in everyday use in different parts of the world and they impede foreign trade ransactions because of their number and compliation. In 1875, an International Conference on Weights and Measures fixed the standards of the International Metric System, and the International Bureau t Sèvres was afterwards established to preserve them. All scientific measurements are expressed in terms of the metric system, and in most countries the use of this system of weights and measures has been adopted. It was legalized in Great Britain in 1897, ut was not made compulsory, though many Chambers f Commerce and other organizations have often urged its adoption, and the Decimal Association has persistently carried on a campaign in favour of it. Developments of mechanical engineering have, however, made a large general public familiar with a number of metric measures. Radio wave-lengths are xpressed in metres, motor-car and aeroplane parts in millimetres or other subdivisions of the metre, and bores of guns and similar ordnance dimensions in the same decimalized units.

The metric system of weights and measures is truly the only system which can claim to be international in its scope and standards; and its use is likely to be extended after the present War. It does not matter much what standards or values are used for special trade or commercial transactions within customary regions or countries, but for business outside such areas, or with other peoples, fixed mercantile standards of an international kind are essential, and those of the metric system have been proved by adoption in most countries of the world to provide what is needed for international business.

In establishing the metric system on the Arabic scale of numerical notation and extending it to decimal fractions, French men of science at the close of the eighteenth century used the best methods of easy reckoning known in the history of mathematics. Their system also provided for a simple and uniform scale of relationships between the multiples and submultiples of the standard instead of the varying and unrelated quantities preserved in such tables as those of British weights and measures, upon which so much time has to be wasted in school and in everyday calculations.

By adopting the decimal scale of notation in the metric system the founders of the system used a natural plan of counting based upon the ten fingers of human hands and customary among more peoples than any other scale. A duodecimal scale has certain advantages over a decimal scale, as it permits simpler expression of halves, thirds and quarters, but it is futile to suggest the general adoption of a twelve or dozen scale either for national or international use. Whatever system of reckoning is used to express numbers and fractions, quantities will continue to be divided into halves, quarters and so on in everyday speech and practice, and new standards of weights and measures will be thought of in old denominations both locally and nationally.

As science is an international study, there must be common standards and units of measurement in all its branches in order to ensure uniform systems of comparison of results. After the discovery of radium and other radioactive elements, it became necessary to give quantitative values to their properties and to express them in agreed units. This was done by an International Radium Standards Commission, which adopted the quantity of radium emanation (radon) in equilibrium with one gram of radium as the standard unit and gave the name Curie to it. Units of physical science have thus entered the field of radioactive therapy.

One of the many useful services rendered by the Health Organization of the League of Nations has been the establishment and supply, on an international basis, of a series of 'standards of reference' by means of which the potency of many important specific agents used in medicine can be accurately determined and expressed in a commonly accepted system of notation. The series comprises standards for the assay of the antitoxins, the arsphenamines, the vitamins, insulin, the active principle of the posterior lobe of the pituitary body, many of the newly introduced sex hormones and the heart drugs.

Before the War, the international biological standards for the arsphenamines, vitamins, hormones and heart drugs were maintained at the National Institute for Medical Research, Hampstead, London, and those for the antitoxins and tuberculin at the State Serum Institute, Copenhagen. After the occupation of Denmark, the League of Nations asked the Medical Research Council to undertake the supply of the standards for the antitoxins and tuberculin to those countries which had hitherto received these essential materials from Copenhagen. More recently, an international standard for vitamin E has been established and made available, and the work towards the establishment of a standard for the important anticoagulent, heparin, has been completed.

A World Language

Primitive man was able to represent objects and motions by drawings, and by doing so he used a sign language understood by all peoples. Sir Richard Paget, who has devoted much attention to this subject, has shown that the close relationship between the movements of the hand and mouth would associate the symbolizing of objects with sounds and gestures, and thus combine art and emotional expression in a sign language. The representation of objects is still preserved in the Chinese writing of a few characters, and in the infancy of the language two or more characters were combined to suggest a third thing or idea. The Chinese language was afterwards built up of characters representing sounds or phonograms instead of pictorial symbols or ideographs. An educated Chinese to-day will, however, draw ideographs to be read by a fellow countryman who speaks a different dialect.

Drawings provide a universal means of representing objects, and their characters also convey individual or composite emotions and meanings. Many early forms of writing are conventional characters developed from pictographs of this kind, and out of these conventionalized marks alphabets were constructed or characters were combined to represent syllables. All human beings express certain emotions, such as anger and fear, by much the same sounds, signs and gestures, and all can interpret simple picture writing, as all can understand the meaning of actions reproduced in moving pictures, silent or sound. There are, however, many conventionalized forms of characters to represent these sounds and thoughts by written or printed words, and these combinations make up the many languages of the world.

Among the important problems of an international kind to be promoted now and after the War is that of a means of expression in a language easily learnt and used by all civilized peoples of the world. The International Morse Code of signals is an example of an accepted system of alphabetical and numerical communication, and what is wanted, now is an auxiliary vehicle of language which will be as widely understood. The subject of an international auxiliary language has long been under discussion, but we seem to be no nearer agreement as to what this language should be than we were after the War of 1914–18. In 1921, the British Association published a careful and comprehensive report on this subject, prepared by a committee representing humanistic as well as scientific interests, and in collaboration with the chief associations concerned with classical and modern languages as well as by consultation with a number of learned societies.

The British Association Committee was appointed after the International Research Council, at a meeting in Brussels in 1919, had taken up the question of an international auxiliary language and recommended the formation of an international committee to inquire into the position and outlook of the subject. It was hoped that a central international organization would be formed, under the League of Nations, and be empowered to make the final selection of the international auxiliary language, if feasible, and to take measures to ensure for it the greatest possible degree of stability. Chairmen were appointed to represent national committees for France, Italy, Japan and Belgium, and the chairman of the British Association Committee undertook to represent Great Britain on the Committee of the International Research Council.

The desirability of an international auxiliary language having been unanimously approved by the British Association Committee, attention was given to the advantages and disadvantages of the following three types: (1) a dead language, for example, Latin; (2) a national language, for example, English; (3) an invented or artificial language, for example, Esperanto or Ido.

The claims for the use of each of these languages as an international auxiliary language were justly and concisely stated by their own specialists in the report of the Committee. After careful consideration of this and other evidence from high authorities at home and abroad, the Committee found itself unable to pronounce judgment in favour of a particular auxiliary language for international use. The conclusions reached may be expressed as follows: (1) Latin is too difficult to serve as an international auxiliary language, and its advantages are outweighed by its disadvantages. (2) The great international languages of the past have all borne the marks of imperia prestige which prevented them from being welcomed by alien races. The adoption of any modern nationa language by the common consent of the chief nations is therefore unlikely, as it would confer undue advantages and excite jealousy, however impartial the promoters of the language might be. (3) Invented languages constructed on scientific principles and adaptable to many diverse requirements are practicable means of international communication. They are neutral and have advantages of simplicity not possessed by most national languages. Wha auxiliary language of this kind will meet with genera approval remains to be decided by internationa agreement.

In the interest of international communication and the free expression of ideas, it is to be hoped tha academic as well as scientific and commercial organizations will assist in the movement towards an agreed auxiliary language. A committee of th British Association on post-war university educatio has dealt with the subject recently in one of th sections of its report. It recommends that apar altogether from the academic study of language and literature, every university should require its student to be able to make themselves understood, by speec and writing, in an auxiliary international language The Committee suggests that the Universities Burea of the British Empire, in consultation with the American Universities Bureau and the Associatio of University Professors and Lecturers of Allie Countries in Great Britain, could take up the subjec very appropriately and prepare a report upon it. There is no better way of promoting interrelationships between the peoples of the world than that a simple common language; and the constructio of such an instrument should not be beyond the powers of responsible authorities—literary, scientifi and commercial—working together in a commo and needful purpose.

THE MENDELÉEFF–BRAUNER TRADITION IN CZECH CHEMISTRY

By Dr. GERALD DRUCE

Ever since the founding of the University of Prague in 1348, the Czechs have made their contributions to the advancement of science. In the Middle Ages, Prague and other Czech towns were centres for the practice of alchemy and a number of their pharmacies date back to these times.

Even during the dark days of the seventeenth century some Czech exiles, notably J. A. Komenský (Comenius), whose pansophism influenced some of the early members of the Royal Society, and the alchemist, Daniel Stolczius, maintained a high standard of knowledge and tried to lay the foundations for a wider and more general study of science when better days returned. Meanwhile, science was at a standstill in their homeland; no lectures or training were given until the end of the eighteenth century, when a scientific revival set in, and the biological sciences attracted most attention. Indeed, it was not until the time of Bohuslav Brauner (1855–1935) that Czech chemistry attained a world-wide significance.

Curiously enough, it was Brauner who did much to popularize the Periodic System postulated by D. I. Mendeléeff in 1869[1] and which might easily have received the ridicule accorded Newlands' Law of Octaves in 1863, though it was more likely to escape attention altogether on account of its appearing in an obscure Russian publication, especially as contemporary Western science was indifferent to so-called 'speculatory' articles.

The rapid verification of Mendeléeff's bold prediction of the existence of undiscovered elements, for which he left spaces in his Table, directed attention to his work, and it remained for Brauner and others to attempt to clear up the obscurities and anomalies. Thus, in order to establish his system, Mendeléeff had been obliged to alter certain accepted atomic weights (for example, that of beryllium) and to invert the order of others (for example, the pairs cobalt–nickel and tellurium–iodine). There were other problems such as that of the rare earths. To all these, Brauner gave his attention, as Mendeléeff frequently acknowledged[2], and there thus developed a cultural 'neo-Slavism' as distinct from the political 'Pan-Slavism' of last century. This found expression, too, in Brauner's advocacy of the Czech transcription for Russian names[3], Mendeléeff being rendered Mendělěěv, a system that is more accurate but less acceptable in Great Britain on account of the diacritical marks involved.

In 1877, Brauner adduced evidence[4] that beryllium must have an atomic weight of 9, not 13·5 as previously supposed. This was confirmed by Nilson and Petterson, so that beryllium heads Group 2 of the Table, in accordance with Mendeléeff's arrangement. From his own investigations and by a critical study of those of Crookes and others, Brauner came to the conclusion that the rare earth elements, from lanthanum to lutecium, should be lumped together in the Periodic Table[5]. This work included his classical fractional separation of didymium into the three elements, neodymium, praseodymium and samarium. Brauner next devoted himself to the task of the exact determination of atomic weights, and his figures for a number of these (cerium, beryllium, praseodymium, tellurium, thorium and lanthanum) were accepted as the standard ones[6]. He was unable, however, to clear up the problem of the inverted order of tellurium and iodine, a question that was only solved after the discovery of atomic numbers.

In 1902, when the Periodic Classification was firmly established, Brauner again visited Mendeléeff, and his lecture at St. Petersburg (Leningrad) was one of the last meetings that Mendeléeff attended. In the following year the new Chemical Institute of the Charles University of Prague was opened, largely as a result of Brauner's efforts and through the international reputation he had by then acquired[7]. With better facilities at his disposal Brauner was able to educate a generation of Czech chemists before the War of 1914–18 brought liberation to his nation. A number of these continued in his researches on the rare earths, the most noteworthy being Prof. J. S. Štěrba-Böhm, who prepared and examined the lesser known compounds of cerium, scandium and germanium. Among the substances he prepared were a long list of double cerium oxalates[8] and many double salts of scandium, while his later researches on germanium[9], starting with a supply of argyrodite, brought the early work of Winkler up to date. His son, Dr. J. P. Štěrba-Böhm, was just beginning his career and had completed an interesting research on the sulphates, selenates and carbonates of scandium[10] when the Germans marched into Prague.

Brauner's atomic weight determinations were continued at his institute by Prof. H. Křepelka, who has shown equal skill and patience in estimations relating to arsenic, aluminium[11] and silver[12], Prof. O. Tomiček, who succeeded Prof. Štěrba-Böhm, had already specialized in improved methods of potentiometric analysis which were applied to the estimation of traces of elements as impurities and in evaluating the saline contents of thermal waters[13].

Probably the most outstanding contribution to chemical science made by Brauner's successors is the polarographic work of Heyrovsky[14] and his collaborators. This method, using the dropping mercury cathode, was first described in 1925, and though a steady stream of communications on the subject continued to appear, it was not until several years after that the full significance and importance of the method were appreciated. During the last few years it has found very wide application in many different directions. With the polarographic apparatus analyses can be carried out with so little as 2 c.c. of solution of 10^{-6} molar concentration and only requires that a known amount of the material under examination be brought into convenient solution, with perhaps the elimination of any interfering element. The automatically recorded polarogram constitutes a permanent record of the information obtained.

It was used, among other things, for the detection of Mendeléeff's dvi-manganese (rhenium) in crude manganese salts[15] and may thus be said to have assisted in filling one of the gaps in the Periodic Table, allowed for by Mendeléeff in 1869. Most of these gaps have now been filled, several during the period that Czechoslovakia was able to expand its scientific and research programmes. Thus, in 1922, hafnium was discovered[16] (or re-discovered), and Brauner put in a plea for the retention of Urbain's name, celtium, for this element[17]. Mention has been made of Czech contributions to the discovery of the congeners of manganese, now known as masurium and rhenium. A third congener, which would have an atomic number of 93 and would thus be the next element beyond uranium, was announced by Koblic in 1935[18]. It was said to be present in certain residues from the working up of pitchblende for radium at Jáchymov (St. Joachimsthal), but as spectroscopic examination failed to reveal any new body, Koblic soon withdrew his claim to the discovery of bohemium, as he called the new element. In passing, it may be mentioned that in 1934 the hundredth gram of radium was extracted at Jáchymov, though by that time the Czech source of radium and pitchblende had lost its importance since far greater supplies are available in the Belgian Congo and near the Great Bear Lake in Canada. Nevertheless, Czech chemists and radiologists made valuable studies and applications of their supplies, particularly in medicine.

Brauner's life and work were influenced not only by his contacts with Mendeléeff but also by his connexions with Great Britain. His first interest in England began when as a boy he received a chemical set known as "Tutton's Chemical Box", which Prof. Frič took back to Prague from London. Later, in the 'eighties, he studied at Manchester under Roscoe and afterwards revisited England, taking the opportunity to read some papers before the Chemical Society[19]. It therefore became a part of his tradition that promising students were sent abroad to widen their outlook. Thus Štěrba-Böhm went to Paris to work under Moissan and Becquerel, Heyrovský came to London to hear Ramsay, Donnan and many other contemporary great chemists, Křepelka went to the United States to work under Richards. Between 1918 and 1938 a number of Czech students went abroad to spend at least a year of their academic life under Western influence. To-day it is only abroad that they are able to continue their researches and studies, for in the "protectorate" all universities and institutes are closed. When the nation is again liberated and the universities are opened once more, there is no doubt that the Mendeléeff-Brauner tradition of Czech chemistry will again inspire the nation's chemists to achieve results for the general advancement of science and the welfare of mankind.

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[1] In March 1869, Mendeléeff circulated a memoir among members of the Russian Chemical Society. It set out his views on the periodicity of the elements and contained his first Periodic Table. The memoir was later reprinted in the Society's *Journal*.

[2] For example, in his "Principles of Chemistry".

[3] Nature, **109**, 552 (1922).

[4] *Chem Listy*, **2**, 30, 87, 129 (1877).

[5] *J. Chem. Soc.*, **41**, 68 (1882); *Ber.*, **11**, 872 (1878).

[6] *J. Chem. Soc.*, **67**, 549 (1895).

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LANDSCAPE IMPRESSION AND THE EXTERNAL BASIS OF NATURAL BEAUTY

By L. C. W. BONACINA

It is often said with some truth that this century has seen a welcome change from the last towards a desire to bring scientific knowledge and æsthetic appreciation of Nature more into line in human thought. Yet there were already signs of a change of outlook during the nineteenth century. That shrewd cosmopolitan thinker, Alexander von Humboldt, who helped to lay the foundations of so many of the geophysical and geographical sciences and saw so much of Nature in many lands, considered that it was not altogether possible to dissociate æsthetics from science in the study and contemplation of landscapes. As to Victorian England, it is instructive in this regard to note the respective attitudes of Tyndall and Geikie, for example, in science, and of Ruskin and Wordsworth in art and poetry.

Whatever may have been John Tyndall's theological views there can be no question that the whole outlook upon Nature of this celebrated physicist was consciously and deliberately artistic, and there are passages in his "Hours of Exercise in the Alps" which almost vie in descriptive power with Ruskin himself, leaving the reader with the conviction that to this great-hearted Irishman there was much more in the mountains than was comprised in their dimensions, form, structure and composition. Similarly, the eminent Scottish geologist, Sir Archibald Geikie, displays in his "Landscape in History and other Essays", which considers the human response to different types of country in Great Britain as also in Italy and Greece, highly imaginative insight into those imponderable but powerful environmental influences so vividly reflected in literature. Conversely, though the art critic, John Ruskin, may have given vent to irritable denunciations of scientific research, no one more loudly proclaimed the importance for creative work of careful and accurate, that is, scientific observation of natural phenomena, even going so far as to declare quite unjustly to Constable and others that no landscape painter before Turner had ever really looked at the clouds. In like manner, though William Wordsworth may have passed occasional rude remarks about geologists and astronomers, there is something in his very Nature-mysticism, unique among the great English poets, which is very reassuring from the wider philosophical and scientific point of view, and it is surely significant that a Wordsworthian text should have been selected as a motto for Nature. Throughout Wordsworth we discern in the background tacit acceptance of scientific principle which makes for stability and enhances the value of much deep and passionate expression of feeling. There is a curious passage in the second book of "The Prelude" wherein the poet is thinking of the sun and moon both as cosmical bodies and as elements in the local landscape, and says of the latter, with respect to a beloved Cumbrian vale, that she hung

> "Midway between the hills, as if she knew
> No other region, but belonged to thee,
> Yea, appertained by a peculiar right
> To thee and thy grey huts, thou one dear Vale !"

This passage is valuable as seeming to illustrate a difficult, almost painful, spiritual attempt on the poet's part to co-ordinate and harmonize astronomical knowledge with artistic perception of the moon in relation solely to the local scene. It typifies that dual attitude of mind which every contemplative lover of Nature who is both man of science and poetical impressionist will find daily opportunities to exercise.

We are now in the twentieth century in sight of a more rapid convergence of the paths followed by the scientific investigator and the interpreter of natural beauty which, it is to be hoped, will eventually unite into one clear line of approach to truth about the external world. It is highly probable that the change is being accelerated in large measure by the fact that the various theoretical enigmas and paradoxes accruing to the great modern discoveries in physics and biology, together with the perplexing far-reaching implications of the doctrine of relativity, have taken us, metaphysically speaking, out of our depth, but in so doing have served to break down the hindering rigid distinction between 'subjective' and 'objective' fact which formerly appeared final. To-day the very meaning of traditional conceptions is becoming strained and challenged to such an extent as to force thinkers into the wholesome practice of putting in inverted commas all controversial terms which it seems to them either have not been, or cannot be, exactly defined.

Hence it seems fitting at the present time to reconsider the question whether the quality of beauty cannot be brought into closer scientific relationship with the grosser attributes of natural phenomena. If those who study Nature from the æsthetic side will help men of science by paying attention to accuracy of observation and to the subjection of their flights of imagination to scientific discipline, they will find themselves automatically in scientific company without loss of any power in their own proper sphere. Reciprocally, if men of science will respond to the overtures of artists and boldly confront the question whether natural beauty with all the ennobling emotions which it begets may not be something deeper and more systematized than a wayward subjective reaction to mere matter, they may soon discover fresh vistas opening out before them, so enlarging the scope of their own endeavours. It is indeed imperative in this complicated problem that scientist and artist should work together in order constantly to put questions to one another which neither would think of in isolation.

Landscape is not, of course, the only source of the experience of natural beauty, but since it comprises so much of human environment it affords a peculiarly convenient and effective one for the interchange of ideas as between science and æsthetics. For in the landscape the observer, whether scientific or artistic, becomes aware of a multitude of sense impressions from earth, water and sky for the descriptive differentiation of which language is quite inadequate. Words fail, for example, to denote the distinctive shades of 'green' which characterize the summer foliage of various species of trees even in identical illumination. In short, landscape observation brings both the seeker of physical facts and the lover of beauty up against the subtler truths of sense impression, and this in itself is a valuable corrective of the dangerous tendency of the human mind to think in categorical or class concepts in consequence of the limitations of speech. It is seldom suspected that a large amount of unnecessary controversy in many a field of thought arises out of the fact that the names we bestow on common objects, qualities and phenomena are in essence class-concepts concealing differences between members of the same group. This is why statistics involving broad categories are inherently dangerous and require much care in their interpretation. Contrariwise, it is the peculiar value of landscape impressionistic study that it leads to the intensive exercise of every sense-faculty, and thus invites the scientific observer and the artistic observer to walk together and exchange experiences derived from the concrete presentation of particular scenes. When the senses perceive so much more of reality than words can cope with, classes and categories, which are, after all, only mental attempts to arrange Nature's bewildering medley of overlapping, interlocking facts, are soon forgotten.

The question whether beauty is a quality residing in the object perceived or in the mind of the perceiver has long been at issue in philosophical circles, but this provides yet another example of the common fallacy of expecting a simple answer to an intricate question. It is very doubtful, indeed, whether the metaphysical distinction between beauty as a 'tertiary' attribute of matter, colour as a 'secondary' attribute and shape as a 'primary' attribute will bear searching logical analysis, for obviously beauty has certain objective or external foundations whatever purely subjective or personal elements may enter into its evaluation. The external physical basis of beautiful scenery consists in the association of a vast number of elements of form, colour, lighting, movement and the like, an association in which the human spirit discerns harmonious relationship. Now it is admitted that without sentient creatures all the wealth of landscape expressed in light, colour, sound and scent would vanish from the world even though the physical counterparts thereof as electromagnetic vibrations, air-waves and corpuscular emissions would remain. Similarly, though beauty as such might cease to exist upon the earth in the absence of man with his higher spiritual faculties, the physical counterpart thereof, namely, certain pictorial relationships of material elements, would be there just the same, for the external basis of a beautiful view does not depend on the presence of a spectator. It has been argued against the reality of any objectivity in natural beauty that people appreciate it so differently, some being largely blind and insensible thereto; but it might as well be argued against the reality of the grosser attributes of matter that some persons, through physical blindness or deafness, cannot see or hear them. Certainly in the exercise of a spiritual faculty like the æsthetic sense there should be scope for beauty to be variously interpreted, since different minds will tend to capture different aspects of the truth; but within such diversity there is a large measure of unity, particularly among persons of culture. When a common standard of reference for æsthetic values has been discovered, defined and agreed upon, the fallaciousness of this kind of argument will become apparent.

As the medium through which the scenic glory alike of the heavens and the earth is witnessed by the observer, the atmosphere plays a highly critical part, because every scene must be viewed through some sort of light and weather. In fact, the diversity of scenic moods exhibited by every landscape is evidently in response to a delicate balance of meteorological factors. The fact in itself opens out a promising field for joint investigation by artists and meteorologists, as I have shown elsewhere in a series of essays on landscape meteorology. Readers of Thomas Hardy, who so skilfully portrayed his Wessex characters against what might be called the 'elemental' background of solitary heaths, woods and downs, may recall a passage in "The Return of the Native" wherein it is told that the great Dorset Heath could by its very expression anticipate the frowning of storms scarcely generated. This is more than a vivid local picture inasmuch as it typifies the mysterious manner in which the aspect of the country the world over responds to subtle unsuspected changes proceeding in the atmosphere, as though the slightest alteration in its physical condition as to light, temperature, moisture and other factors produced its counterpart in the æsthetic expressions of mountain, sea, forest, lake and the like. Theoretically it should be possible to relate the atmospheric states to the scenic expressions of the landscape, but in practice it might prove impossible to scrutinize the air with the closeness which a problem of such extreme intricacy would require. Nevertheless, the attempt would be well worth while if only it resulted in the formulation of a new vocabulary for the description of the 'scenic expression' in terms satisfactory to artists and men of science alike.

A suggestive fact in the problem of landscape beauty is the relationship between kindred features as members of a company. Just as a human personality needs to be drawn out by others, so does the scenic individuality of the trees, rocks and hills gain by interrelationship. We know how in a mountainous land the great peaks impart to one another a bearing which enhances the grandeur of the whole array, giving a new meaning to the music of torrent and cataract and the picture of gleaming glaciers. Similarly, along a high rugged coastline is it not the viewing of the multitude of rocky profiles in mutual relationship which gives the cliff scenery much of its inspiring character as we listen to the rhythmic impact of storm-waves or the low sinister murmur always uttered by the sea on such a coast in quiet weather ? Sometimes, too, the very clouds gather in noble companies, as when gloriously lit in rifted storm masses—not the less suggestive because so transient. Then take the trees. Solitary trees admittedly can be superb, as a spreading oak or beech in field or park, a commanding ash on the skyline, a graceful birch at the entrance to a Highland glen, a shapely hawthorn in full blossom on the hillside, or a rowan tossing in wind and spray amid the boulders of a moorland stream ; but it is nevertheless true that when trees of the same species grow in company with ample room for free individual development their beauty is intensified by pictorial interrelationship. Thus lofty elms often form groupings of the utmost elegance about English country lanes and village churches ; but perhaps nothing in tree-beauty can exceed the magnificence at all seasons of the year of a fraternity of great oaks disposed or inclined towards one another in every comely posture, as commonly at the foot of a range of hills. In short, the universality of this kind of scenic companionability throughout the types of Nature furnishes a fundamental fact for contemplation and will demand much thought as the foundations of beauty are sounded.

The part played by animals in scenic beauty though, perhaps, less obtrusive than that by plants, is nevertheless of great importance in introducing two distinctive æsthetic elements, the one of living forms in motion against the physical background, and the other of mental reactions to the environment, both of which add much to our human sense of the geographical personality of different regions. This is a strong argument, apart from other reasons, for the strict preservation of what remains of the indigenous fauna of Britain or of any other country where the fauna is threatened. The song and notes of wild birds are so essentially part of the beauty of the landscape that it becomes a question to what extent our enjoyment of them, unlike that of the more elaborate musical compositions of man, really depends on this fact. Thus a divine melody of Chopin or Schubert need lose nothing from being heard in a city slum, but it is at least arguable whether the full emotional appeal of the trills and cadences of the nightingale is not inseparable from the sight or memory of such an associated setting as a flowery woodland dell or garden shrubbery in the month of May. Again, though the plaintive cry of lapwings may not be particularly beautiful in itself, it can become decidedly inspiring when these handsome plovers are seen with cattle and horses wheeling in a half stormy light over vividly green, high-perched meadows climbing up to moorland, as typically in Devon and other western counties.

Evaluation of the objective foundations of natural beauty is, of course, affected by various personal factors as, for example, knowledge, which is often a safeguard against spurious, illusory or incomplete impressions. Thus at least an elementary knowledge of the geological structure of a locality is essential to the full measure of appreciation of the beauty of the countryside. An artist would certainly miss the whole æsthetic scheme of the Wealden landscapes of Kent, Sussex and Surrey, for example, if he did not appreciate the difference of contour line and of vegetation characteristic of the great parallel ranges of chalk, greensand and Wealden sandstone similar in altitude and regional climate. Knowledge of history and purpose may be the means of awakening a person's susceptibility to the exquisite beauty of our Gothic cathedrals, just as, on the other hand, it has been said that visitors to the Great Pyramid have turned away in disgust on being told that it was built by sweated labour—insensible to its symmetrical perfection which is there all the same. Perhaps in the end they who find it difficult to divorce moral principles from physical attributes may be right.

Finally, we come to the question of the metaphysical meaning of the external basis of beauty. We have seen that it needs mind to translate these external qualities into the actual spiritual experience of beauty, but why should they be present in Nature to be so translated at all ? Whence comes this mysterious expression of harmonious relationship between the component parts of what is called gross matter ? It is a proposition difficult to dispute that the physical universe does actually possess the power to excite æsthetic emotions, and if this be really the fact it points strongly to the position of those philosophers who hold that the background of the universe is mental and the expression of intelligent Deity. Beauty is part of the manifestation of law and order throughout Nature, and its existence implies that the various elements comprising a landscape or other medium exhibiting beauty are related to one another in a manner capable of arousing spiritual pleasure in the beholder. Now if we admit that man's æsthetic faculty may have been evolved in response to some real counterpart existing in Nature in her own right, we may find ourselves on the verge of new knowledge concerning the relation of the human soul to its physical environment; whereas, if we cling to what would seem to be the traditional view that the sense of beauty invests Nature with attributes she does not properly possess, being no more than a private personal subjective reaction to external influences, we shall never get the subject of beauty outside human psychology. The latter alternative spells sheer frustration, whereas the former at any rate looks promising. With this crucial issue the problem must be left for the present, but the article may appropriately be concluded with a quotation from the concluding chapter of the late Mr. J. W. N. Sullivan's "Bases of Modern Science": "The fact that a piece of matter has been reduced by relativity theory to a system of events, that it is no longer regarded as the enduring stuff of the world, makes the hypothesis that the 'physical' and the 'mental' are essentially similar very possible. . . . Our æsthetic and religious experiences need not lose the significance they appear to have merely because they are not taken into account in the scientific scheme. It is indeed possible that they will not always remain excluded from the scientific scheme." It is my growing belief that they will not and cannot remain so excluded.

ROLE OF HYALURONIDASE IN FERTILIZATION

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AQUEOUS extracts of mammalian testis contain a 'spreading' factor which dramatically increases the permeability of the skin to injected fluids. This factor is associated with the germinal epithelium and can be extracted from spermatozoa[1]. Factors with similar diffusing properties have been obtained from the most diverse sources, for example, from culture-filtrates and extracts of many species of invasive bacteria[2], from snake and spider venoms[3] and from leeches[4]. Chain and Duthie[5] reported a remarkable mucolytic activity of these extracts characterized by a rapid fall in the viscosity of synovial fluid and the liberation of reducing substances. This observation has been confirmed and extended by other workers and it appears that these spreading factors are closely associated if not identical with a group of enzymes that hydrolyse the hyaluronic acid of the synovial fluid, vitreous humour, umbilical cord and skin[6], and which are therefore known as hyaluronidases.

The role of the hyaluronidase of spermatozoa in fertilization has not hitherto been explained. Experiments designed to show whether this enzyme causes an increase in the permeability of echinoderm eggs comparable with that occurring immediately after fertilization yielded negative results[7]. Recent (unpublished) observations on the activity of the enzyme on bovine cervical mucin during œstrus and in the resting phase were also negative.

The presence of a transparent, viscous fluid or gel in which the cumulus cells and corona radiata surrounding the tubal egg of the rat are embedded was described by Long[8]. The removal of this substance and the consequent disintegration of the cell mass is necessary to enable the sperm to penetrate the egg. According to Pincus and Enzmann[9] the dispersal is brought about by a heat-labile substance produced by the spermatozoa. Earlier work by Yamane[10] showed that a preparation of pancreas removes the cells surrounding the egg of the rabbit, an observation which was confirmed by Pincus and Enzmann[11], who used purified trypsin. They observed, however, that in addition to removing the cells, partial digestion of the egg occurred, and so it is highly improbable that the process of denudation of the egg in the Fallopian tube is effected by trypsin or a similar proteolytic enzyme. The facts recorded above suggested that hyaluronidase might be responsible for the phenomenon, and the following experiments were carried out.

Ovulation was produced in immature rats and the eggs removed from the Fallopian tube as previously described[12]. The action on the gel and cell masses of hyaluronidase obtained from various sources (see table below) was investigated. In addition, the supernatant fluid of a centrifuged suspension in Baker's solution[13] of rat sperms killed by heating at 50° C. for five minutes and a similar preparation of rabbit semen were tested, together with the secretions of the seminal vesicles (vesicular fluid) and prostate of adult rats. The action of some detergents such as sodium glycocholate was also recorded. The action of all these substances was observed in the following manner: 0·2 ml. of saline (0·8 per cent sodium chloride) was pipetted on to a watch-glass and an equal volume of enzyme dilution added and mixed. A cluster of 6–12 eggs was then immersed in the mixture and the rate of dispersion of the cells

THE ACTION OF HYALURONIDASE AND OTHER SUBSTANCES AND PREPARATIONS ON THE DISPERSION OF THE CUMULUS CELLS OF THE RAT OVUM.

Substance tested	Hyaluronidase		Time taken to disperse cumulus cells and corona radiata (min.)
	v.r.u./ml.	m.c.p. test	
Bovine testis hyaluronidase	0·6		165
	0·85		142
	6·0		36
	8·5		33
	15·0		20
	15·0		20
	30·0		17
	60·0		11
	85·0		9
Streptococcal hyaluronidase	0·6		100
	6·0		32
Cl. welchii hyaluronidase	5–7·5		27
	10–15		19
Vibrion septique hyaluronidase	2·5		30
Rattlesnake venom			
0·5%*		+	17
0·05%		+	27
Rat sperm extract*		+	12
	3·25		22
Rabbit semen extract*		+	18
Rat and guinea-pig vesicular fluid		—	No effect in 2 hr.
Rat prostatic fluid		—	” ”
Taka diastase, 0·5 %		—	78
Diastase, 0·5%		—	No effect in 3 hr.
Sodium glycocholate 0·5 %		—	” ”
Baker's solution		—	” ”
Physiological salt solution		—	” ”

* Ten minutes heating at 100° C. destroyed activity as shown both by m.c.p. test and inability in a period of 3 hours to disperse the cells surrounding the egg.

observed under a binocular dissecting microscope. The action of hyaluronidase would appear to be solely one of liquefaction of the gel, which causes the cells to fall away from the ovum and collect on the bottom of the watch-glass. The end-point of the reaction was taken to be the complete denudation of the egg. Accurate timing of this point is difficult because a few cells may adhere to the eggs after the reaction is apparently complete. These cells, however, can be displaced quite easily by slight agitation of the watch-glass. The cells and the egg appeared to be unaffected by the enzyme.

The hyaluronidase titre of various samples of enzyme is recorded in viscosity-reducing-units (v.r.u.) or by their capacity to prevent the appearance of a typical mucin clot on the addition of acetic acid to a substrate consisting of albumin and hyaluronic acid (m.c.p. test).

The table shows that the rate at which the cumulus cells were dispersed is closely correlated with the concentration of hyaluronidase, obtained not only from spermatozoa and testis but also from *Streptococcus*, *Cl. welchii* and *Vibrion septique*. The activity of the enzyme derived from bacteria and from snake venom, and the close correlation with the activity of testicular hyaluronidase, is additional evidence that this is a specific effect of the enzyme, since it is unlikely that preparations from such diverse sources would all be contaminated with some other active agent.

Cell masses exposed to the action of detergents such as sodium glycocholate become almost invisible but the gel is not liquified. The impaired optical definition of the cells might be due to lowering of surface tension of the cell boundaries. Of interest is the fact that even after careful and prolonged washing of these cell masses, the action of hyaluronidase is afterwards inhibited. Further work is being carried out in this connexion.

The absence of any action of vesicular and prostatic secretions on the gel is additional proof that the hyaluronidase content of semen is of testicular origin. Moreover, the evidence recorded above, although entirely circumstantial, suggests that the gel surrounding the eggs in the Fallopian tubes contains hyaluronic acid.

The production of such enormous numbers of sperm for the fertilization of the mammalian ovum and the fact that the reduction in the sperm count rapidly leads to sterility has always aroused interest. It is clear that the intromission of a large number of spermatozoa is required to ensure that even a single one shall enter the egg. If a large number are required in the immediate vicinity of the egg, then their purpose may well be the production of a concentration of hyaluronidase sufficient to liquify the hyaluronic acid gel and so allow penetration of the egg by the single effective sperm. The possibility should be borne in mind that a deficiency of the enzyme may cause certain types of sterility for which there has been, hitherto, no obvious explanation, and investigations on the hyaluronidase content of semen in infertility are contemplated.

We are indebted to Dr. C. Rimington for many helpful suggestions and advice, and to Dr. H. King, who supplied the rattlesnake venom.

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NEWS and VIEWS

Newton Tercentenary Meetings

IT is inevitable that, as the human race grows older, jubilees and centenaries should multiply—indeed, unless due discrimination be shown, there may be a weariness in their multiplication. But, if ever there was a single outstanding name in the history of scientific achievement, that name is Isaac Newton's, and, in the noble words of his lapidary inscription in Westminster Abbey, men of science the world over will rejoice that such and so great a glory of the human race has been permitted to dwell among us for a season. The story of Newton's surpassing achievements in dynamics and optics, of his fashioning of the mathematical tools necessary to his adventures, of his excursions into theology and chemistry is a long and involved one. Myth and legend have grown around Newton's almost superhuman figure—and yet he was human enough in many aspects. No doubt many of these myths can be dispelled by the light of modern scrutiny, but in telling the tale of his immortal work, we shall be the better able to assess the greatness of Newton's influence on his contemporaries and successors.

Newton was born on Christmas Day, 1642, and the Royal Society is marking the tercentenary year by devoting its anniversary meeting on November 30 to commemorative lectures. These will be delivered during the afternoon in the lecture theatre of the Royal Institution. Prof. E. N. da C Andrade is speaking on "Newton and the Science of his Age" at 3 p.m.; and after a brief interval, at 4 p.m., Lord Rayleigh will lecture, with experiments on "Newton as an Experimenter" and Sir James Jeans on "Newton and the Science of Today". It is also hoped to arrange a small exhibition of Newton manuscripts, instruments and other relics. The Physical Society has also arranged a commemorative lecture, which will be delivered by Prof. Andrade in the lecture theatre of the Science Museum, London on December 4 at 4.30 p.m. and in the Cavendish Laboratory on December 9 at 2.30 p.m.

Josef Bohumir Mikan (1742–1814)

J. B. MIKAN, a pioneer in the revival of the study of science in Bohemia, was born two hundred years ago, on December 4, 1742, at Česká Lípa in North

Bohemia. He studied medicine at Prague under Count William Macneven, whose Irish forbears accompanied James II to the Continent in 1689 and became landowners in Bohemia. Count William was director of medical studies in the University of Prague and took a prominent part in supporting the incipient Czech cultural revival during the era of 'enlightened absolutism' under Joseph II. Through Macneven, Mikan, who had become a practitioner at the spa of Teplice, was appointed professor of botany and chemistry at the university in 1775. This post he held for thirty-seven years, lecturing and carrying out research. He re-established proper courses of instruction and made it obligatory for students to qualify in both chemistry and botany as well as in their other subjects. In order to secure proficiency Mikan established the first chemical laboratory in Prague in 1784 and also laid out a botanic garden that is still in existence. The laboratory was a primitive affair adapted from a store-house of the original Carolinum, but it enabled him and his assistants to undertake the first analyses of many Czech spa and thermal waters.

After 1792 'enlightened absolutism' gave place to the 'reactionary absolutism' that lasted until 1848 and under which science was not encouraged. Not until 1810 were more commodious laboratories put at Mikan's disposal, and such progress as he was able to make was achieved in the face of much opposition, although a few progressive nobles gave him and his students encouragement and financial aid. Mikan was thrice dean of the medical faculty (there was no science faculty until much later) and was for many years vice-director of studies. When he retired in 1811 two appointments were made. His son, Jan Kristian Mikan, who had previously acted as his assistant, became professor of botany, and J. Freysmuth was appointed lecturer in chemistry. At his time there were no contemporary scientific publications in Czech, so that Mikan's writings are all in German and his name is usually rendered J. Gottfried Mikan. His work was, nevertheless, of vital importance for the advancement of science among the Czech nation.

Finance and Social Service in Great Britain

THE recent Political and Economic Planning (P E P) broadsheet "Fair Shares for All" (No. 192) is a fitting counterpart to that issued earlier in the year under the title "Financial Mysticism" (No. 188). The latter made a useful contribution to lucid thinking about five simple questions: the financing of the War; the risk of national bankruptcy; the value of 'warship weeks'; export policy; and the repayment of the National Debt. In regard to the first of these uestions, the point is driven home that the real ost of the War is the sweat and sacrifice it imposes, part of which is borne by the present and part by the future. In regard to bankruptcy, the false analogy between State and individual spending is exposed, while the true object of 'warship weeks' of helping us to get warships without inflation is clearly indicated. Similarly, the importance of subordinating trade policies, when peace returns, to the over-riding aim of winning the peace, is demonstrated as well as the necessity of regarding the national resources as sum of man-hours instead of a sum of pounds erling, and of the imperative need for avoiding aste of men and material either by unemployment the misdirection of resources.

In the later broadsheet, a realistic analysis is given of civilian consumption and the war effort, which suggests concisely the directions in which taxation and rationing might be further extended to promote first the war effort, but simultaneously lay the foundations for social reconstruction after the War, by giving priority to the poorest groups of the population as part of a national consumption policy to wipe out malnutrition. A much more determined attack on the 'vicious spiral' from the under-consumption end is required. The essential problem here is that of subsidizing consumption among families with several children, and accordingly family endowment is now the chief weapon which must be used to combat under-consumption, though the problems of prisoners, the sick, the families of men in the Forces, and of workers receiving unusually low wages, must be considered. Much more needs to be done in respect of school-feeding services and tax relief for children before the existing services providing family endowment benefits can be regarded as adequate. Further development of the subsidized food schemes, a definite family allowance scheme, co-ordinated with existing services and for occupations where earnings are very low, and wage increases to a reasonable minimum are other proposals designed to secure a comprehensive policy and develop the maximum war effort.

Illusions about the Size of the Moon

PROF. E. G. BORING and his associates at the Harvard Psychological Laboratory have quite recently undertaken precise measurements to determine how large the moon appears, both on the horizon and near the zenith (*Sky and Telescope*, Sept.). Various observers compared the moon with an artificial moon placed at a standard distance, and the size of the artificial moon could be varied to agree with the real moon. An arrangement was made to control the orientation of the observer's head, so that the angle between direct vision and the elevation of the moon could be measured. The artificial moon, placed at a distance of 12 ft., appeared from 2° to 6° in diameter to people with normal vision and using both eyes. The experiments were conducted to choose between four modern theories which are associated with the physiology of the eye. The old theory that the moon is contrasted with terrestrial objects when near the horizon is ruled out by the fact that this illusion disappears when we view the horizon moon with the head upside down. The theory that the celestial sphere looks flattened overhead, the apparent distance of the moon thus varying, is also eliminated. Ames's theory alone out of the four modern theories is not finally rejected. When the eyes are raised, it has been found that the right eye tends to rotate clockwise, as viewed from the back, with respect to the left eye, and this fact may explain the moon illusion for binocular vision. It is admitted, however, that the results are not conclusive.

Technical Basis of Sound Reproduction

AT the November meeting of the British Institution of Radio Engineers, held at the lecture hall of the Institution of Structural Engineers on November 21, Dr. L. E. C. Hughes read a paper on "The Technical Basis of Sound Reproduction". His treatment of the subject was based on his experiences as technical adviser to the Central Council for School Broadcasting, and was general in character. Dr.

Hughes described the various degrading effects on sounds by the chamber in which they are emitted or reproduced. The final test is always a subjective one, and owing to the short memory of the ear it is necessary for comparisons between the original performance and the reproduction to be direct. This is difficult, and the method Dr. Hughes advocated was to use two separate chambers with a microphone in each to represent the listener, and to compare their outputs subjectively at the remote end of a very good quality amplifier.

Dr. Hughes explained that each letter has its own requirements in the matter of frequency range for good reproduction of speech, but he stressed the point that the final test is always an aural one in the tests conducted by the Apparatus Approval Committee of the Central Council for School Broadcasting, where non-technical audiences vote subjectively on the quality of reproduction on a scale attained entirely by experience. In the discussion which followed, doubts were expressed as to the validity of subjective tests, but Dr. Hughes stated that a completely new panel had, in duplicate tests, returned votes which were within 1–2 per cent in agreement with the regular panel.

Michelia Timbers for Aircraft

A SERIES of leaflets has recently been issued from the Forest Research Institute, Dehra Dun, on utilization matters. No. 17 deals with the species of Michelia of which the *champaca* (champ) is the most important, being fairly common in Assam and cultivated all over India for its fragrant flowers. Its true habitat is in the Eastern Himalaya, Sikkim and Assam. There are four other species of the genus in India, but they are less abundant. The timber of the five species is very similar in weight and strength and is only slightly heavier than spruce (being about 33 lb. per cubic foot as against 30 lb. for spruce) and compares very favourably with spruce in strength.

Michelia timber seasons without difficulty or degradation; it is straight grained and very easy to work both by hand and machine tools. It can, it is said, be finished to a beautiful smooth surface and is a pliant wood to handle; also it can be peeled on a rotary lathe and sliced on a slicing machine to produce excellent veneers for plywood. It is not surprising, therefore, that this timber should prove very suitable as a substitute for Sitka spruce in the manufacture of aircraft. It is stated that though supplies are limited, if the wood of these species is reserved for aircraft construction in India alone, available supplies would go some way to supplying the needs of the industry. This takes one back to a century ago when the same remarks were being made in Malabar and Tenasserim in connexion with the teak demands of the Bombay Dockyard and the Admiralty in Great Britain.

Indian Woods for Battery Separators

LEAFLET No. 14 of the Utilisation Section, Forest Research Institute, Dehra Dun, deals with investigations into woods for battery separators. The battery separator is a thin sheet made of wood, ebonite or glass interposed between the positive and negative plates of an acid storage battery in order to prevent the plates from touching each other during handling or use, while at the same time allowing the ionic exchange to take place in the electrolyte. When wood is used its essential characteristics must be good permeability, freedom from volatile acids, low percentage of tannins and resinous matter, sufficient mechanical strength and resistance to chemical action of the electrolyte. The most commonly used timber has been the American *Chamæcyparis lawsoniana* or the Port Orford cedar. The Indian Forest Research Institute has been investigating the suitability of Indian timber for the purpose for some time past. The research work has shown that the following are suitable for use as battery separators: *Adina cordifolia* (*haldu*), *Cupressus torulosa* (cypress), *Michelia champaca* (champ or champak), and *Talauma phellocarpa*. The leaflet describes some of the tests carried out. As regards the Michelia it is more likely to be earmarked for aeroplane construction than battery separators, unless the wastage from the former can be utilized for the latter.

Horticultural Science

SEVERAL papers upon scientific aspects of gardening have appeared in recent numbers of the *Journal of the Royal Horticultural Society* (vol. 67). Dr. B. A. Keen expounds his doubts of the value of hoeing except for the destruction of weeds (Part 10; Oct. 1942). This conception must now express the ideas of many workers who have considered the mechanism of water movement in soil. The experiments quoted are upon an agricultural scale, but should also have direct reference to horticulture. M. Mather publishes further work upon the effect of the moon on germination and seedling growth (Part 8; Aug. 1942). He again finds no consistent lunar influence, but can explain all the differences recorded for tomato and maize by the effects of temperature and light. The moon is not known to exert a great influence upon these two factors. Other experiments on growth of tomatoes are those of Dr. M. A. H. Tincker (Part 8), who finds that extracts of the vitamins in yeast do not improve growth or enhance the vitamin B_1 content of the plant.

Air Vice-Marshal A. E. Borton records (Part 10) satisfactory control of the Rhododendron bug *Stephanitis rhododendri* by spraying with an atomized pyrethrum wash. 'Die-back' disease of apricots makes cultivation of this crop difficult in Great Britain. H. Denham and H. Wormald show (Part 8) that the trouble is caused by the brown rot fungus *Monilia cinerea* (*Sclerotinia laxa*). It can be controlled by the removal of shoots with wilted flowers or leaves, or dead twigs. Spraying with copper carbonate washes is also mentioned.

Rubber Economy in Typewriter Cylinders

ACCORDING to an article by A. R. Kemp (*Bell Lab Rec.*, 20, No. 12; August 1942) savings in the rubber used for typewriter cylinders are now possible as a result of experiments recently carried on in the Bell System Chemical Laboratories. These cylinders consist of an arbor of steel or wood over which is slipped a sleeve of rubber. The rubber is vulcanized on the arbor, and then ground to the proper size and to roughen its surface so as to grip the paper firmly. With extensive use, the cylinders become hard and glazed, and no longer hold the paper securely. They have then been returned to the factory to have the old rubber removed and new rubber put in its place. It has been estimated that from fifty to one hundred thousand cylinders need to be renewed each month.

Tests have shown that by sand-blasting the glazed cylinders for two or three minutes, using No. 90 steel grit and an air pressure of 15–20 lb., a surface was formed that in many ways was superior to the original. The reduction in cylinder diameter due to this resurfacing is less than 0·002 in. Cylinders treated in this manner have had hard service in Bell Laboratories for more than six months without showing need for further treatment. Cylinders that have been ground have a grooved structure, while sand-blasted cylinders have an irregular pattern of minute projections that grips the paper firmly in all directions. The sand-blasting, moreover, knocks out the fine particles of filler compound that otherwise would reduce the friction between paper and cylinder, much as talcum powder would. Typewriter cylinders vary considerably in size, but on the ordinary letter-page machine the rubber weighs about 1 lb., and with more than a million replacements a year, sand-blasting promises a considerable saving of rubber compound.

Cancer Mortality

THE June issue of the *Statistical Bulletin*, the organ of the Metropolitan Life Insurance Company of New York, contains an editorial based on a series of observations extending over a number of decades, from which the following conclusions emerge. While the recorded mortality among males from all forms of cancer has shown an increase by about one third in the course of thirty years, the rate among females has changed but little. Towards the end of the period there has been some improvement among females, while there has been a slackening in the upward trend for males. The result has been that the rates for males and females at ages 1–74 which widely differed in 1911–15 have converged to a common level of 86·8 per 100,000 in the quinquennium 1936–40. A substantial cause of the rise in cancer mortality among males is probably due to improved diagnosis—a supposition confirmed by a consideration of the mortality from cancer of the various organs. Since 1911 mortality of cancer of the peritoneum, intestines and rectum has practically doubled in the case of males and increased by about 50 per cent in females. The mortality from cancer of the pancreas and prostate has also risen sharply. The rise in the death-rate from cancer of the lung and pleura has been attributed to improvement in diagnostic technique. The most hopeful outlook occurs in the case of those organs which are readily accessible such as the female genital organs, the skin and mouth, in each of which the mortality has declined since 1911. Cancer of the breast is exceptional in that, in spite of its accessibility, its mortality has increased during the thirty years. The improvement due to early recognition and treatment of suspected growths is illustrated by the fact that the American College of Surgeons has records of more than 36,000 cases of so-called "cured" cancer.

Health of the United States Army

ACCORDING to the War Department, the army training in the United States is in better health than ever during war-time. It is anticipated that the general hospital admission rate in 1942 will be about 10 per cent lower than in 1941. Venereal disease is substantially less than during the War of 1914–18, the syphilis rate being the lowest in army history. The total venereal diseases rate was 40·5 per 1,000 men in 1941 and 38 per 1,000 during the first six months of 1942. Throughout 1941 and thus far in 1942, the death-rate has been the lowest in army history. During this period, from one half to two thirds of the deaths resulted from external causes such as traffic accidents. The meningitis fatality rate in the army is far below that in civil life. The malaria rate per 1,000 men in the Continental United States was only 0·61 for the first eight months of 1942 as compared with 1·24 in 1941. Universal vaccination has virtually eliminated smallpox, and rigid sanitary control and inoculation have rendered typhoid almost non-existent. The incidence of scarlet fever is now extremely low.

Public Health in Brazil

THE September issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an article by Dr. João de Barros Barreto, director-general of the National Department of Health, Rio de Janeiro, who states that this department has the following sections: administrative service; divisions of public health and hospital organization; Oswaldo Cruz institute for the study of prevalent diseases and the manufacture of sera, vaccines and chaulmoogra esters; national services for leprosy, tuberculosis, yellow fever, malaria, plague, mental diseases, control of medicine, port sanitation, water and sewerage, and vital statistics, and since September 23, 1942, the national service for cancer. Courses in public health are given by the National Health Department and include microbiology, immunology and parasitology, vital statistics, physiology, urban and rural sanitation, epidemiology and prophylaxis, industrial, child and mental hygiene, nutrition and public health organization and administration. A number of scholarships are granted to medical men through the Panamerican Sanitary Office.

Fevers in the Sudan

THE recently published report, for 1940, of the Director of Medical Services of the Sudan, contains an account of an epidemic of yellow fever which broke out in that country in July and continued until the end of 1940. The number of known cases was 15,633, of which 1,627 were fatal. The real incidence was probably greater as many of the cases were mild and atypical, and therefore were not notified. The epidemic was particularly remarkable in that, so far as was known, yellow fever had never occurred previously in the Sudan or indeed in any part of the Old World east of the centre of Africa. The report also contains an account of a long-continued epidemic of relapsing fever which started in 1936 and reached its peak in 1940 with 1,487 cases. It is a remarkable fact that though relapsing fever is louse-spread, no mention is made in this report or any of its predecessors of typhus, so that this disease seems to be absent from the Sudan.

Books on Historical Medicine and Science

THE firm of Schuman's, 20 East 70th Street, New York, has recently issued a catalogue "Medical Miscellany List 'F' ", containing a number of interesting books and periodicals of which the following may be mentioned: Sir Benjamin Brodie's "Physiological Researches" (1851), Edwin Chadwick's "Report on the Sanitary Condition of the Labouring Population of Great Britain" (1843), A. Weismann's "Vorträge über Deszendenztheorie" (1904), first edition of Gray's "Anatomy" (1858), William Hamilton's "Observations on the Preparation, Utility and Administration of Digitalis Purpurea or Foxglove" (1807), Francis Home's "Medical Facts and Experiments" (1759), Hufeland's "Art of Prolonging Life" (1797), Lord Lister's "Contributions to Physiology and Pathology" (1859), Thomas Bateman's "Reports on the Diseases of London, and the State of the Weather from 1804 to 1816" (1819), Puschmann's "Handbuch der Geschichte der Medizin" (1902–1905), the first two volumes of *Archiv für Physiologie* (1796–97) and a number of runs of the *Lancet* from 1848 until 1871.

Recent Earthquakes

During the third quarter of 1942, the epicentres of ten strong earthquakes have been found chiefly from instrumental data from American observatories. The first four epicentres in July and August were determined at St. Louis by the Jesuit Seismological Association, and the others in August and September by the United States Coast and Geodetic Survey, in co-operation with the Jesuit Seismological Association and Science Service. On July 8 the epicentre was in Chile (24·5° S., 69·5° W.) with a depth of focus near 175 km. A later earthquake on July 8 and one on July 12 had their epicentres near the coast of Ecuador (0·3° S., 80·2° W.) and a depth of focus near 500 km. The latter was reported felt at Guayaquil. On August 6 the earthquake had its epicentre in the Pacific Ocean off the coast of Central America (12·9° N., 92·1° W.). On August 23 a shock had its epicentre in the Pacific Ocean between the Kamchatka Peninsula and the Aleutian Islands (51·5° N., 163° E.). Further shocks in the same region were on September 2 (52·5° N., 170° W.), September 4 (52·8° N., 169·2° W.), and September 9 (53·1° N., 165° W.). Sequences of shocks in this manner are not uncommon and the present group is somewhat to the west of a similar group some months ago. The shock of August 24 had its epicentre near the coast of Peru (14·5° S., 75·5° W.) with a depth of focus between 50 km. and 100 km. A further earthquake with its epicentre in the Pacific Ocean off Central America (12·5° N., 91° W.) occurred on September 4. On Thursday, October 29, an earthquake was felt in Western Turkey, including Istanbul and Smyrna. No damage has been reported.

A New Comet

A comet was discovered by Oterma on Sept. 11d. 23h. Its position at the time of discovery was R.A., 23h. 51m., Dec. + 6° 20′, and its magnitude was 13. A later telegram announces that the comet was observed again on Nov. 6d. 20h. 16m., and its position then was R.A., 4h. 11m., Dec. − 0° 47′. Its magnitude had not altered. It was stated to be moving slowly northward. An orbit will be computed when a third position is obtained.

The Night Sky in December

New moon occurs on December 8d. 01h. 59m. u.t., and full moon on December 22d. 15h. 03m. Conjunctions during the month are as follows: Dec. 6d. 13h., Mars in conjunction with the moon, Mars 5° S.; Dec. 20d. 17h., Saturn in conjunction with the moon, Saturn 3° N.; Dec. 24d. 13h., Jupiter in conjunction with the moon, Jupiter 3° N. Occultations of stars brighter than magnitude 6 are as follows, the times referring to Greenwich:

	d.	h.	m.		
Dec.	12	19	15·0	μ Capricorni	*D*
	15	22	13·4	14 Ceti	*D*
	20	19	32·7	α Tauri	*D*
		20	44·5	α Tauri	*R*
	26	03	06·2	o^2 Cancri	*R*
			34·0	o^1 Cancri	*R*
	27	23	32·9	45 Leonis	*R*
	28	02	50·2	ρ Leonis	*R*

Mercury, Venus and Mars are not well placed for observation during the month. Jupiter, in Gemini, souths at 2h. 10m. about the middle of the month and is well placed for observation. Saturn, in Taurus, souths at 22h. 50m. in the middle of the month and can be observed all night. The Geminid meteor shower is active during December 7–15, the radiant being close to α Geminorum. The winter solstice commences Dec. 22d. 12h.

Announcements

The Minister of Supply has appointed Prof. J. E. Lennard-Jones, Plummer professor of theoretical chemistry in the University of Cambridge, to be chief superintendent of armament research, and Mr. F. E. Smith, of Imperial Chemical Industries, Ltd., to be chief engineer and superintendent of armament design. These appointments have resulted from the recommendations of a committee under the chairmanship of Dr. H. L. Guy recently appointed by the Minister of Supply to review the machinery for the conduct of research, design, and experimental work in connexion with the development of guns, small arms, and ammunition.

Dr. C. D. Darlington, director of the John Innes Horticultural Institution, has been invited to deliver lectures to the Mendelian Society of Lund in Sweden. He will journey to Sweden under the auspices of the British Council, and, in addition to his lectures at Lund, will speak on cytology to learned societies in other centres, and will also deliver a number of general lectures on a broad biological topic.

The Earl of Moray and Mr. J. M. Bannerman have been appointed members of the Forestry Commission in succession to Sir John Sutherland, who has submitted his resignation, and to fill another existing vacancy. At the request of the Secretary of State for Scotland, Sir John Sutherland has agreed to continue to attend meetings of the Commission so that his experience may be available when matters relating to Scotland are discussed.

The council of the Royal Meteorological Society has awarded the Buchan Prize for 1943 to Dr. T. E. W. Schumann and Mr. Gordon Manley. The Prize is awarded biennially to the authors of the papers published in recent issues of the Society's *Quarterly Journal* which have been adjudged to contain the most important original contributions to meteorology.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Connexion between the Penetrating Non-ionizing Component of Cosmic Radiation and Penetrating Showers

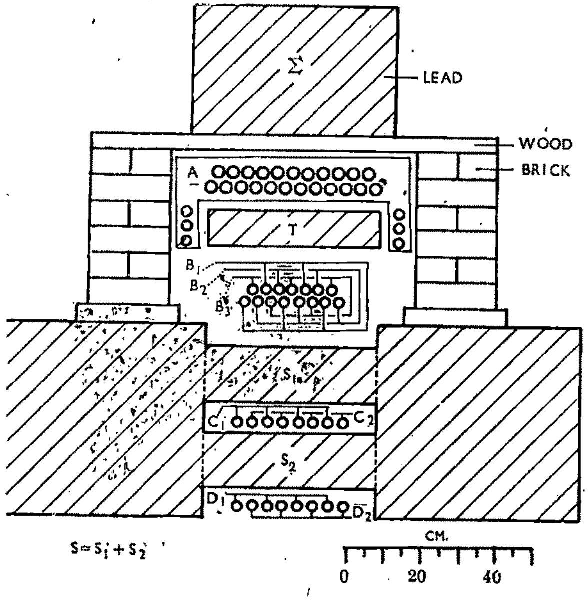
IN a recent publication[1] we suggested that there is a connexion between penetrating showers produced at sea-level and the penetrating non-ionizing radiation discovered by Rossi and Regener[2] on Mt. Evans and by us at sea-level. The present investigation was undertaken with the object of establishing such a connexion. The results show that a considerable fraction of the penetrating showers are produced by a penetrating non-ionizing radiation, but that only a small fraction of this radiation produces penetrating showers.

The experimental arrangement, illustrated diagrammatically herewith, was a combination of the arrangement by which penetrating showers were originally observed[3] and the arrangement used to observe the non-ionizing radiation[1].

Sevenfold coincidences $B_1-B_2-B_3-C_1-C_2-D_1-D_2$ involving counters out of each of the three trays, B, C and D, were recorded; one of us has shown for a similar arrangement[3] that such coincidences are mainly due to penetrating showers.

If the absorbers T and Σ were removed, only penetrating showers coming from the air were recorded. On placing an absorber T above the counter tray B, the coincidence rate increased by $0{\cdot}289 \pm 0{\cdot}062$ coincidences per hour, the increase being due to the showers produced in T. To show that a considerable fraction of these showers were due to non-ionizing agents the following method was used.

The absorber T was covered on five sides by a set of anti-coincidence counters consisting of thirty-five counters in parallel. Thus a non-ionizing particle producing a penetrating shower in T could give rise to an anti-coincidence, that is, a sevenfold coincidence not accompanied by the discharge of any of the counters A. With $T = 10$ cm. of lead, $0{\cdot}086 \pm 0{\cdot}018$ anti-coincidences per hour were recorded. All these anti-coincidences might have been due to non-ionizing particles, but to show that at least part were, in fact, due to non-ionizing rays and not to some spurious effect, observations were carried out with a variable absorber Σ placed above the anti-coincidence set. It was expected that some of the non-ionizing particles moving towards T would be absorbed in Σ. Thus the decrease of the rate of anti-coincidences with increasing thickness of Σ was a measure of the rate of anti-coincidences due to non-ionizing particles.



Absorbers		Time	Coincidences		Anti-coincidences	
T (cm. Pb)	Σ (cm. Pb)	hr.	Total No.	Rate per hr.	Total No.	Rate per hr.*
0	0	306 : 15	162	0·529 ±0·042	5	0·023 ±0·010
10	0	380 : 30	311	0·818 ±0·046	24	0·086 ±0·018
10	5	1289 : 56	1100	0·853 ±0·026	59	0·063 ±0·008
10	35	1344 : 20	924	0·688 ±0·023	33	0·033 ±0·006

* Corrected for random coincidences.

It is clear from the data given in the accompanying table that the anti-coincidence rate falls considerably as Σ is increased from 0 to 35 cm. of lead. We conclude, therefore, that some of the showers produced in T are produced by non-ionizing particles.

The non-ionizing radiation does not seem to consist of photons, as photons would be almost entirely absorbed in 5 cm. lead, while our observations show a marked absorption as Σ is increased from 5 cm. to 35 cm. of lead. It is not unreasonable to assume that this radiation is part of the penetrating non-ionizing radiation reported previously[1,2].

As the range of the non-ionizing radiation cannot be determined accurately from our data, it is difficult to estimate its rate of incidence. Rough calculations, which will be given elsewhere, indicate (1) that the rate of incidence is about 1 per cent of the rate of non-ionizing radiation observed with our previous arrangement[1], and (2) that one third of the penetrating showers produced near sea-level are produced by the penetrating non-ionizing radiation.

Physical Laboratories,
University,
Manchester.

L. JÁNOSSY.
G. D. ROCHESTER.

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[1] Jánossy, L., and Rochester, G. D., NATURE, 148, 531 (1941); and *Proc. Roy. Soc.*, A, in the Press.

[2] Rossi, B., and Regener, V. H., *Phys. Rev.*, 58, 837 (1940).

[3] Jánossy, L., *Proc. Roy. Soc.*, A, 179, 361 (1942).

Purification and Chemistry of Penicillin

THE lability of penicillin is such as to preclude most of the ordinary chemical manipulations. Attempts by us to purify the material by the procedure of E. P. Abraham and E. Chain[1] had little success, perhaps for reasons which appear below. After a lengthy search, we have developed a new chromatographic technique involving a chemical reaction which for the first time provides a rapid means of concentrating penicillin to a high degree with the minimum risk of chemical change.

Penicillin is chromatographed from an organic solvent such as ether or amyl acetate on a column consisting of a water-retentive support such as silica-gel or 'Hyflo-Supercel' which is associated with an inorganic base such as a hydroxide or carbonate of an alkali or alkaline earth metal. The base is applied either in the form of a dilute solution in water, or as a mechanical mixture, or preferably precipitated on the carrier before use; a suitable column consists of a 2·5 per cent precipitate of an alkaline earth carbonate on silica-gel. Doubtless the process is a combination of 'chemical' chromatography and 'partition' chromatography, the constituents of the crude penicillin being separated primarily according to the strengths of the component acids; whereas in the adsorption column, differences in adsorption affinity are magnified by a large number of elutions and adsorptions, in the present process differences in acid strength are magnified by repeated neutralization and acidification. The process is of general applicability, and we have found it can conveniently be used to separate alkaloids on silica-gel retaining a solution of sodium hydrogen sulphate.

The above process leads to theoretical recovery of penicillin and easily affords manifold concentration. Most of the work referred to below was carried out on material (strontium salt) containing *ca.* 500 units/mgm.[2]. We have on occasion obtained material containing 750 units/mgm.

Penicillin obtained by us in the form of its strontium salt after drying *in vacuo* at 60° or 100° gives analytical figures in agreement with the formula $C_{24}H_{34}O_{11}NSr$; electrometric titration gives an equivalent of 249, the smooth curve showing only a single inflexion, from which it would appear that the two acid groups are not adjacent. The salt is yellow and possesses an absorption band at 265 mμ ($E^{1\%}_{1\text{cm.}}$ *ca.* 390) which is unaffected by treating with aluminium amalgam; it appears to have no measurable optical activity.

Very mild inactivation is accompanied by fission of the molecule. We have used dilute acid, alkali, or moist organic bases such as aniline, methylaniline, dimethylaniline or *p*-nitraniline for this purpose (fission with ammonia is more complicated and leads for the first time to fluorescent materials). The isolated products are (*a*) a substantially colourless water-soluble acid, (*b*) varying quantities of a yellow almost insoluble pigment, and (*c*) acetaldehyde which is accompanied by a minute quantity of an αβ unsaturated aldehyde, $C_7H_{12}O$, the significance of which is questionable; no carbon dioxide is liberated. The water-soluble acid affords ether-soluble and ether-insoluble acids on further hydrolysis, of which the second gives a positive ninhydrin reaction; it thus appears to be a simple peptide. The pigment, $C_{16}H_{20}O_6$ or perhaps $C_{16}H_{18}O_5.H_2O$, shows two characteristic colour reactions which we have found reliable indications of the localization of penicillin on the column: the first is a transient cherry-red colour with strong nitric acid, and the second a permanent deep red colour with a dilute solution of sulphuric acid in glacial acetic acid. The pigment possesses absorption bands at 261 and 397 mμ ($E^{1\%}_{1\text{cm.}}$ 290 and 305) but does not appear to be a quinone; although it titrates as a monobasic acid it is more probably enolic in character (a tetronic acid ?). Whenever penicillin is treated with aluminium amalgam it ceases to give the above colour reactions and an insoluble hydrolysis product, now colourless, gives analytical data corresponding to $C_{16}H_{20}O_5$, indicating that this treatment results in reduction. Ozonolysis of the pigment provides acetaldehyde together with other products as yet unidentified, while degradation with alkaline permanganate gives at least three molecules of oxalic acid.

We thank the Therapeutic Research Corporation of Great Britain, Ltd., under whose auspices this work is being done, for permission to make this preliminary statement.

J. R. CATCH.
A. H. COOK.
I. M. HEILBRON.

Imperial College of Science and Technology,
London, S.W.7.
Nov. 13.

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[1] *Brit. J. Exp. Path.*, 23, 103 (1942).

[2] Florey *et al.*, *Lancet*, 241, 177 (1941).

Notatin: an Anti-bacterial Glucose-aerodehydrogenase from *Penicillium notatum* Westling

IT has been shown[1] that when a selected strain of *Penicillium notatum* Westling is grown on a Czapek-Dox medium an anti-bacterial substance is produced which differs in the majority of its properties from penicillin[2,3,4]. This anti-bacterial substance was originally named 'Penicillin A', but in order to avoid confusion with penicillin we now prefer the name 'notatin'. This substance is isolated by concentrating the culture filtrate to approximately one fifth of its volume under mild conditions and precipitating the concentrate with acetone or by producing a complex with tannic acid from which notatin is regenerated by extracting the tannic acid with acetone[5]. The crude substance can be purified further by regeneration from the complexes which it forms with tannic acid and with Reinecke salt. The average yield of purified notatin is 3–4 gm. from 100 litres of culture filtrate.

Notatin is a buff-coloured powder freely soluble in water, but almost insoluble in organic solvents. The aqueous solution has *p*H 6–7 and the activity is rapidly destroyed at *p*H's below 2 or above 8 or by heating to 60° C. Notatin is decomposed by 70 per cent aqueous methyl alcohol at 30° C. and by aqueous trichloracetic acid, yielding a precipitate of protein and a solution containing the prosthetic group, both of which, tested singly, have no anti-bacterial action A typical sample of notatin afforded the following figures on analysis: C, 50·0; H, 6·7; N, 11·8 P, 0·58 per cent, the results being corrected for moisture (11·1 per cent) and ash (5·3 per cent). Specimens containing less than 1·4 per cent ash have been prepared. Some preparations contain a small quantity of catalase, but only traces are present in others

Notatin affords positive reactions in many protein tests and it also responds to the luminoflavin test The absorption spectrum in aqueous solution exhibits maxima at 280, 375 and 465 mμ, which characterize it as a 'yellow enzyme'. The extinction coefficient of the absorption band at 465 mμ runs parallel with the anti-bacterial activity. The other properties of the substance are also those of a flavoprotein and by assuming the molecular weight 73,000, which is that of the majority of flavoprotein enzymes, it can be calculated from the extinction coefficient of the absorption band at 465 mμ that the purity of our best preparations is about 90 per cent. A purified solution of the non-protein part of the molecule was prepared by treating a solution of notatin with trichloracetic acid and applying Warburg and Christian's method[6]; the absorption spectrum of this solution was closely similar to that of riboflavin. The silver salt of the prosthetic group is insoluble, and notatin is therefore probably a dinucleotide.

Notatin only exerts its anti-bacterial activity under certain well-defined conditions, but under these conditions it is a very powerful bactericide. The conditions are:

(1) presence of oxygen;
(2) presence of glucose;
(3) absence of appreciable amounts of catalase.

Our best preparations completely inhibit the growth of *Staphylococcus aureus* in dilutions as great as 1 part in 1,000,000,000. They are also active in very high dilutions against other Gram-positive and Gram-negative organisms including *Strep. hæmolyticus*, *Strep. pneumoniæ*, *Bact. typhosum*, *Bact. paratyphosum A* and *B*, *Bact. typhi-murium*, *V. choleræ*, *Bact. anthracis* and *Proteus vulgaris*.

It has been found that in the presence of notatin, glucose is converted by oxygen to gluconic acid with simultaneous production of hydrogen peroxide. Quantitative experiments indicate that the oxidation may be represented by the equation

$$R.CHO + H_2O + O_2 \rightarrow R.COOH + H_2O_2,$$

although there is a deficiency of hydrogen peroxide when notatin is contaminated with catalase. The whole behaviour of notatin is thus consistent with the view that it is an enzyme similar to, but much more potent than, the glucose oxidase obtained by Müller[7] from *Aspergillus niger* mycelium and further examined by Franke and his collaborators[8], who consider it better described as a glucose aerodehydrogenase.

In vivo experiments are in progress and will be reported at a later date; there is evidence of a therapeutic effect with exceedingly minute doses of notatin.

In a recent publication[9] Kocholaty mentions 'penatin", a newly discovered anti-bacterial substance produced by *Penicillium notatum* Westling, which differs from penicillin. The chemical and bacteriological results given in his communication are insufficient to show whether penatin is identical with notatin.

The work described above was carried out under the ægis of the Therapeutic Research Corporation of Great Britain Ltd. A more detailed account of the investigation will be published in due course.

C. E. COULTHARD. R. MICHAELIS.
W. F. SHORT. G. SYKES.
Boots Pure Drug Co., Ltd.
G. E. H. SKRIMSHIRE. A. F. B. STANDFAST.
The British Drug Houses Ltd.
J. H. BIRKINSHAW. H. RAISTRICK.
London School of Hygiene
and Tropical Medicine.
Nov. 14.

British Patent Application No. 13242 of October 14, 1941: Boots Pure Drug Co., Ltd., C. E. Coulthard, R. Michaelis and W. F. Short.

Fleming, *Brit. J. Exp. Path.*, **10**, 226 (1929).

Clutterbuck, Lovell and Raistrick, *Biochem. J.*, **26**, 1907 (1932).

Chain, Florey, Gardner, Heatley, Jennings, Orr-Ewing and Sanders, *Lancet*, **239**, 226 (1940). Abraham, Chain, Fletcher, Florey, Heatley and Jennings, *ibid.*, **241**, 177 (1941). Abraham, Chain and Holiday, *Brit. J. Exp. Path.*, **23**, 103 (1942). Florey and Jennings, *ibid.*, **23**, 120 (1942).

British Patent Application No. 8189 of June 15, 1942: The British Drug Houses, Ltd., and G. E. H. Skrimshire.

Biochem. Z., **298**, 150 (1938).

Biochem. Z., **199**, 136 (1928); **205**, 111 (1929). *Ergebnisse der Enzymforschung*, **5**, 259 (1936).

Annalen, **532**, 1 (1937); **541**, 117 (1939).

J. Bact., **44**, 142 (1942).

Transformation of Benzpyrene in the Living Skin of Mice into a Compound Soluble in Dilute Alkali

THE skin of white mice painted with benzpyrene fluoresces violet at first, but within two to four days the colour of the fluorescence changes slowly to blue. The blue persists for two to three weeks, until it cannot be distinguished from the natural bluish-white fluorescence of the skin[1]. The spectrum of the violet fluorescence contains the typical groups at 427 and 455 mμ of molecularly dispersed benzpyrene. The blue spectrum contains two diffused bands at about 450 and 425 mμ. It is similar to, but apparently not identical with, the fluorescence spectra of 'BPX'[2,3] and the orthorhombic crystalline modification of pure benzpyrene[4]. It is, however, different from the fluorescence spectrum of the monohydroxybenzpyrene which Chalmers and Crowfoot[5] have isolated from the fæces of rats injected with benzpyrene. We have also observed this blue fluorescence in the kidney cortex, liver and lung of mice and rabbits, and in the protein fraction of the milk of lactating mice after injection of benzpyrene[1].

In a new set of experiments the skins of white mice were painted with benzpyrene in acetone and the mice were killed after various periods from ½ hr. to eight days. The skins were then removed, dried and extracted with cold benzene to remove the loosely attached benzpyrene. Fluorescence spectrography of the transparent skins mounted in xylol between slides showed the 'blue' bands from about six hours after painting. They increased in strength until the fourth day and then faded slowly. The dry skins of 1- to 4-day mice were treated overnight with (*a*) 0·01 *N* caustic soda and (*b*) 0·01 *N* hydrochloric acid.

(*a*) The alkaline extract fluoresced blue, while the extracted skin retained some of its fluorescence; after acidifying, the blue fluorescence could be extracted with ether and re-transferred to the aqueous phase by adding fresh alkali.

(*b*) The acid did not show any fluorescence due to benzpyrene, but on extracting the acid-wet skins with ether, blue fluorescence (with weak violet bands deriving from traces of unextracted molecular benzpyrene) entered the ether. The blue fluorescence could be transferred to the aqueous phase with 0·01 *N* caustic soda, and re-transferred into ether after acidifying.

It must be concluded that the blue fluorescence is due to a benzpyrene derivative which is soluble in alkali. It is produced in the painted skins, and persists over periods of several weeks.

We established by low-power microscopy in ultraviolet light that a strong blue fluorescence followed exactly the rows of the hair bulbs. This indicates that the compound is confined to the quickly proliferating cells of the Malpighian layer. It may therefore be of greater importance for the production of tumours than the original benzpyrene itself, especially because this blue-fluorescent compound persists in the skin long after the parent hydrocarbon has disappeared.

Mount Vernon Hospital,
Northwood, Middlesex.
Nov. 11.
J. C. MOTTRAM.
F. WEIGERT.

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[1] Weigert, F. Brief reports in *Chem. and Ind.*, p. 641 (1941) and *Brit. Emp. Cancer Campaign Report*, p. 90 (1941); full account in the Press.

[2] Peacock, P. R., *Brit. J. Exp. Path.*, **17**, 164 (1936).

[3] Chalmers, F. G., *Biochem. J.*, **32**, 271 (1938).

[4] Weigert, F., and Mottram, J. C., NATURE, **145**, 895 (1940).

[5] Chalmers, F. G., and Crowfoot, Dorothy, *Biochem. J.*, **35**, 1270 (1941).

Condition of Freshly Burnt Gases

IN his interesting article[1] on "The Condition of Freshly Burnt Gases", Dr. A. G. Gaydon gives very clear expression to his view that during the combustion of dry carbon monoxide mixtures the freshly formed carbon dioxide is charged with a large excess of vibratory energy which is only very slowly partitioned; but if the carbon monoxide mixtures are moist, or a little hydrogen is added to them, partitioning of the excess vibratory energy in the carbon dioxide takes place rapidly because of the powerful deactivating influence of water vapour. Experiment, however, seems to indicate that this view is untenable.

It has been found that the *rate* of emission of infrared radiation measured after (even immediately after) the combustion of reasonably dry carbon monoxide – air mixtures is not greater than that measured after the combustion of similar mixtures in which a little of the carbon monoxide is replaced by hydrogen[2]. Indeed it is rather less, because water vapour radiates more powerfully than carbon dioxide. At all times after combustion, the *rate* of emission of radiation from carbon dioxide, like that from water vapour, would appear to be dominated by flame gas temperature (mean molecular translational energy) and influenced not at all by its previous combustion history.

The question as to whether or not normal gases would luminesce if externally heated to the temperatures usually attained in flames and explosions is one of long standing, and Dr. Gaydon redirects attention to it in his article. He suggests that gases like nitrogen, oxygen and carbon monoxide would not luminesce, and probably there will be general agreement with this view. He thinks, however, that carbon dioxide would luminesce after the fashion of carbon monoxide flame gases on account of the recombination which is continuously taking place after dissociation.

But there is, I think, much evidence for the contrary view, and some of this has been referred to by me in a previous communication[3]. Even more convincing evidence seems to be provided by the flame photographs of carbon monoxide – oxygen explosions taken by Bone and Frazer[4]. The photographs show that when these mixtures are ignited by means of an ordinary spark, the usual luminosity is displayed by the resulting flame gases (for example, photograph No. 19). When, however, they are ignited by means of a very powerful spark, a considerable volume of the gases formed under its influence is dark (for example, photographs Nos. 22 and 23), and this in spite of the fact that an enormous amount of dissociation and recombination must be taking place in them, for their temperature is of the order of 3,000° C.

It is not without interest to observe that the long-tube explosion photographs of Bone and Frazer[5] suggest that flame gases also tend to approach the condition of normal hot gases just immediately after detonation has been set up (see, for example, photographs Nos. 5, 17, 22 and 32).

While Dr. Gaydon's article makes it clear that explanations differ, it is becoming increasingly recognized that the experimental evidence for the existence of a long-lived latent energy in carbon monoxide flame gases is irrefutable. The experimental evidence that it exists in hydrocarbon and hydrocarbon flame gases is, I think, equally irrefutable[6].

W. T. DAVID.

Engineering Department,
The University,
Leeds.
Nov. 2.

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[1] NATURE, 150, 481 (1942).

[2] *Phil. Mag.*, 15, 177 (1933), Figs. 2 and 4.

[3] NATURE, 150, 291 (1942).

[4] *Phil. Trans. Roy. Soc.*, 228, 197 (1929).

[5] *Phil. Trans. Roy. Soc.*, 230, 363 (1931).

[6] NATURE, 150, 521 (1942), and *Phil. Mag.*, 22, 513 (1936).

PROF. DAVID refers to his experiments with Parkinson on the rate of emission of radiation from explosions. In this paper I find no mention of any drying process for the gases, or of any attempt to remove adsorbed moisture from the explosion vessel. I therefore assume that the gases were far from dry, and these experiments can scarcely be compared with those of Garner and colleagues to which I referred. They appear to me to support my statement that the concept of vibrationally activated molecules could not explain afterburning or latent energy of long duration in hydrogen-rich fuels. Also I may perhaps be permitted to quote Prof. David's own words relating to some earlier work on coal-gas – air explosions[1], that the "rate of emission of radiation is a maximum about 1/40 sec. before the attainment of maximum temperature". This effect is also very well shown in the curves of David and Parkinson to which Prof. David refers, Curve A in Fig. 2 showing a difference of about 0·03 sec. and Curve B in Fig. 3 of more than 0·05 sec., although for mixtures rich in hydrogen the effect is not observed.

I have shown[2] that the radiative life of the asymmetrical vibration for carbon dioxide is of the order 0·01 sec. and that even in absolutely dry gases the time for equipartition of vibrational energy will be, at most, a few tenths of a second, and very considerably less in the presence of moisture. It is doubtful whether a bolometer of 0·02 sec. period (as used by David and Parkinson) would be adequate for work on moist gases.

With regard to the luminosity of hot gases, I still retain an open mind. I have made it clear in my article and book that the radiation from a carbon monoxide flame is mainly due to chemical causes, and the failure to record appreciable light from hot gases in the neighbourhood of a powerful spark using a very short exposure time proves nothing, except that there is less chemical action taking place. This is probably the result of the pressure wave reducing the time-lag in the equipartition of vibrational energy, and thereby the amount of abnormal dissociation.

I do not feel qualified to express an opinion as to the existence of long-lived latent energy in hydrogen and hydrocarbon fuels. I have already pointed out that there is much apparently contradictory experimental evidence.

A. G. GAYDON.

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and Technology,
London, S.W.7.

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[1] *Phil. Trans. Roy. Soc.*, A, 211, 375 (1911).

[2] "Spectroscopy and Combustion Theory", p. 121. (London: Chapman and Hall, 1942.)

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX

SEVENTEENTH ANNUAL CONFERENCE

THE sixteenth annual conference of ASLIB (Association of Special Libraries and Information Bureaux) was planned to be held at University College, Nottingham, in mid-September 1939, but had to be cancelled owing to the outbreak of hostilities; the papers which were prepared for that Conference were afterwards published. The previous Conference had been held at Oxford in 1938 during the Munich crisis. Any idea of holding a succeeding conference in 1940 was rudely shattered by the Battle of Britain, but the comparative lull in the autumn of 1941 encouraged ASLIB to embark on the project of resuming its annual conference in 1942, with the limitation that the principal meeting should be held in London, and the papers there read and discussed should be available for subsequent local meetings in various provincial centres.

The decision to hold the London Conference proved to be very happy, and the generosity of the Royal Society in providing accommodation for the meetings and other functions greatly contributed to the successful outcome. In all, 137 members of ASLIB and visitors attended the several sessions, which occupied the afternoon and evening of November 7 and the morning and afternoon of November 8, and were preceded on the morning of November 7 by the annual general meeting of the Association.

At this meeting, Prof. R. S. Hutton, Goldsmiths professor of metallurgy, Cambridge, was elected president for the ensuing year, in succession to Sir Harry Lindsay, who had served since November 1939. Mr. Theodore Besterman was elected honorary secretary in succession to Mr. Edward Carter, and Mr. E. Lancaster-Jones was re-elected honorary treasurer. At a later meeting of the council, Messrs. Carter and Lancaster-Jones were re-elected respectively chairman and vice-chairman of the council.

The Conference opened at noon on Saturday with a characteristically stimulating address on international systems and standards given by Sir Richard Gregory. The main part of Sir Richard's address is printed elsewhere in this issue (p. 620).

At the first session of the Conference proper, under the chairmanship of Prof. A. C. Egerton, two papers dealing with training in the use of libraries were presented by Mr. C. H. C. Osborne, honorary secretary of the School Libraries Section of the Library Association, and Prof. R. S. Hutton respectively. The former dealt with school and the latter with university libraries, and each indicated the extent to which instruction in the methodology of libraries might be imparted, with mutual benefit to the library and its user. Comparisons of conditions in Great Britain with the practice in other countries, especially in the United States, was deprecated by some speakers in the subsequent discussion, on the grounds that conditions were not comparable. Nevertheless, the feeling was general that more could be done by librarians and educational authorities to educate those who would ultimately have to depend largely upon reference literature in the technique of extracting it from the vast resources of modern libraries.

At the second session, on the evening of November , Dr. Luxmore Newcombe, of the National Central Library, took the chair and the audience listened with avidity to Mr. Besterman's demand for a "Union List of Periodicals in British Libraries". In his customary blend of dogmatic confidence that difficulties were merely so many bubbles to be pricked and experienced skill in deflecting the anticipated missiles of more substantial composition, Mr. Besterman carried his hearers into a calm and purposeful realm of accomplished fact. One had the distinct impression that the Union Catalogue was as good as in one's hands, and some of us who have experienced the tenacity with which its proponent pursues an objective on which he has set his mind had the uneasy conviction that in due course we should be involved in the usual mass of collation attendant upon the production of all Union Catalogues.

Nevertheless, we shall be willing victims, for all of us realize that these monumental contrivances are essential to the ultimate objective of planned economy and efficiency in our national resources of vital reference periodicals. The two editions of the "World List of Scientific Periodicals" have done a great deal in the period intervening between the two World Wars to enable Great Britain to build up its resources, particularly of the more obscure foreign scientific and technical periodicals. Much remains to be done, but all previous Union Catalogues and lists have largely ignored the wealth of reference material that now exists in the various special libraries.

A paper on "Agriculture and the War Stimulus" by Mr. C. S. Orwin, director of the Agricultural Economics Research Institute, had to be taken as read in the absence of its author or any suitable substitute for him.

At the third session, on the morning of November 8, Colonel E. E. B. Mackintosh, director and secretary of the Science Museum, took the chair for a symposium on microfilms, which attracted a very appreciative audience. Mrs. Lucia Moholy, director of the Aslib Microfilm Service, sketched the early uses of microphotography for communication of information in war-time and proceeded to describe the evolution and functions of the Aslib Microfilm Service in the present emergency. To a considerable extent the Service is occupied in photographing on microfilm current issues of foreign scientific and technical periodicals that emanate from enemy or enemy-controlled countries and are received in very small quantities in Great Britain. The microfilms are used to provide additional copies of the whole issues or excerpts therefrom, as required by individuals or institutions having no access to the originals, or desiring their own copies. The necessity for the provision of reading apparatus to enlarge the microfilms to legible dimensions was stressed, as the supply at present available in Great Britain is wholly inadequate.

Mrs. Moholy's interesting paper was followed by one by Mr. E. Lancaster-Jones, keeper of the Science Library, in which the attributes of the microfilm copy of a normal reference book or volume of a periodical, as compared with the original, received detailed consideration. The possibilities of supplementing the microfilm copy by various guides in order to adapt it to facile use by the staff and clients of a reference library were sketched. A further paper by Dr. Vernon Tate, of the National Archives, Washington, D.C., had been promised for this symposium, but was unavoidably delayed in transit. As Dr. Tate's experience of microfilm technique is profound, this was a great disappointment.

In the subsequent discussion on the two papers, many helpful remarks were made upon the provision of reading apparatus by the adaptation of available mechanisms, such as cinema projectors, to the purpose, and there is no doubt that those individuals who possess the skill and equipment to carry out the minor constructional modifications needed can produce a reasonably efficient machine for enlarging the films, certainly for the purposes of individual research. But one has only to handle an efficient commercial reader, specially designed for the work, to realize that its construction is the result of long experience of the problem, and the results are very satisfying. A small exhibition of reading apparatus, arranged by the Aslib Microfilm Service, proved very popular and instructive.

The final session of the Conference, under the chairmanship of Mr. T. R. Dawson, of the Research Association of British Rubber Manufacturers, was devoted to a paper by Mr. J. E. Wright of the Post Office Research Station on "Some Methods used in the Special Library of a Research Department", followed by one on "War-time Books and Periodicals : some Suggestions", by Mr. B. M. Headicar. Mr. Wright's paper was not merely an account of the methodology of the particular library of the Post Office Research Station, but also contained a rich fund of information and suggestions adapted to use by any similar library; a series of clues to specific requests for information was perhaps the most interesting and instructive section of the paper. Mr. Headicar dealt in his customary adept manner with a multiplicity of practical details, including suggestions for economy in paper and binding; he illustrated his address by greatly appreciated practical demonstrations of the methods recommended.

SEASONING OF TIMBER

By ALEXANDER L. HOWARD

Necessitas non habet legem ("Piers Plowman", 1377).

WHILE it is true that the harsh dictates of necessity have resulted in many discoveries and useful practices in the seasoning of timber, laws regarding the process are adamant; and although simple, the principles which govern the procedure are unalterable. The sap and moisture contents must be drawn out of the wood and the necessary methods employed to bring the wood to that degree of moisture content desired. The process must be varied according to the species of timber and the purpose for which it is required.

Never in the history of Great Britain has this question been of such vital importance as it is to-day. Commodities of all sorts—food, delicate instruments, ammunition, and war material of all kinds—must be packed safely for transport over great distances and under trying conditions, and it is essential that the cases used for this purpose can be relied upon to preserve their valuable contents.

Of those materials which can be used, timber plays the most important part. We are forced to rely to a very great extent upon available native timber, which could be put to better use if adequate facilities for seasoning existed.

It has been proved that timber of many kinds, and in the dimensions required, can be seasoned in a satisfactory manner in a short time, and indeed there are already many established kilns fully occupied and successfully working, but in no sense sufficient for the demands of total war. Even though it involves great expense and effort, many more drying kilns of efficient design should be established as quickly as possible to make good this deficiency.

Fortunately, the lessons of the War of 1914–18 and scientific research have enabled us to overcome all the main difficulties, and the chief problem that concerns us is no longer the method to be employed, but the establishment of sufficient kilns throughout the country.

The primary object is to create within the kiln a continuous and regular current of air (at first charged with moisture) to suit the condition of the unseasoned or fractious wood, and then to withdraw the moisture and introduce the heat by carefully controlled degrees, until the desired percentage of moisture contents has been acquired. To accomplish this, it is essential that every square inch of the timber should be subjected to an equal volume of the current, and while the dimensions of the kiln play an important part, by far the greater importance lies in the scientific application of the correct combination of moisture and heat.

During the course of the last hundred years, innumerable processes have been tried out, many of which have been patented but later abandoned Among these systems is a process which might be described as a 'bakery'—that is, one in which the timber is placed in a compartment somewhat similar to an oven. Other ingenious systems have been tried in which the wood is subjected to a vacuum, with water and steam introduced later. Another process has been to place the timber in boiling water accompanied by the introduction of saccharine or other ingredient, and a still further attempt has been made by the use of an electric current. Most of these, or perhaps all, have been abandoned, at least so far as commercial practice is concerned: at another time and in more easy circumstances, it would be desirable to enter into further scientific research, which migh give us more information and thus secure even bette results. At present our endeavour should be to concentrate our attention towards providing that which we know can secure an immediate as well as a satisfactory result.

Two methods are available, which are what are known as the 'progressive' and the 'compartment kilns, both well understood and universally accepted

For large quantities of box boards the progressiv method would probably be efficient, but this system would not succeed when applied to the more fractious and difficult woods, when the compartment system should be adopted.

In the progressive kiln the wood is placed o trucks, allowing sufficient air space between the boards. The trucks are moved under control throug successive chambers which have been prepared wit the necessary saturation of moisture and the introduction of dry heat. The moisture contents ar gradually withdrawn and the dry heat increased On completion, the charge is found to contain that correct percentage of moisture contents which was calculated as ordered.

In the compartment system, as the name implies the timber is piled with similar air ventilation, bu in a fixed chamber where moisture and heat are introduced. As in the case of the progressive kiln the moisture is gradually withdrawn and the hea increased, so that after the necessary period, which varies according to the description and thickness of wood, whether fractious or kindly, the chamber may be opened and the charge will be found to conform to any given degree of moisture contents stipulated. Complete reliance can be placed on either of these methods.

The outlay required to provide an adequate number of such kilns throughout Great Britain will, of course, be heavy, but having regard to the urgency, this consideration ought to be of secondary importance.

An ample supply of properly seasoned timber for the boxing and safe transport of the vital necessities of war is essential to our war effort, and until this question has been adequately dealt with we may suffer serious losses, not only financial but also endangering the health and welfare of our troops and those of our Allies.

NEW AND LITTLE-KNOWN FISHES

THE *Stanford Ichthyological Bulletin*, published by the Natural History Museum of Stanford University, is responsible for many valuable descriptions of fishes, and the two numbers before us 2, No. 4, Aug. 24, No. 5, Aug. 31, 1942) contain various papers, the most striking of which are George G. Myers's "Studies of South American Freshwater Fishes" and Albert W. C. T. Herre's "New and Little Known Phallostethids, with Keys to the Genera and Philippine Species". The Natural History Museum of Stanford University has amassed a large collection of South American fishes, which, together with the very extensive South American material in the California Academy of Science, forms probably he finest series available anywhere for the study of South American fluviatile ichthyology.

In the present work are included fishes from Amazonian Peru, from Venezuela and from Rio de Janeiro. Especially interesting is *Hoplomyzon atrizona* n.g. et sp., a new Bunocephalid from Peru, which is armed with a series of bony plates along the body, and apparently has no close relatives. It is adapted for life in swift water and the head has maxillary barbels strongly resembling some of the ill-stream Nematognaths.

Many new Cyprinodonts were collected by Lieut.-Col. and Mrs. White in the coastal plain of the State of Rio de Janeiro, their object being to study them in their own aquaria. Fishes of the genus Cynolebias re favourites with aquarists and are known to be annual fishes with a full life-cycle within one year. They are usually found in isolated water holes, swamps and ponds which dry up in the dry season, only the eggs surviving in the mud. After hatching in the wet season, development of the fry is rapid and in some instances full growth is attained in two or three months. The species of this genus, wing to their specialized habitat and seasonal occurrence, are seldom seen by ordinary ichthyologists and are usually only obtained through commercial aquarium fish collectors. The present eries is therefore specially valuable. It includes many new forms of these very beautiful small fishes hich in life are brilliantly coloured. Five of the new species are described and notes given from olour sketches made from the living material.

Herre's paper on the Phallostethids describes many of these peculiar fishes, which are all very small and almost transparent with very little colouring. The sexes are strongly dimorphic, the male possessing a special bony organ lying on the outside of the head which serves for clasping the female. Eighteen species are so far known, occurring in brackish and salt water in Malaya, Singapore, Siam, Borneo and the Philippines, in mountain brooks in Luzon and lowland freshwater creeks in Siam and Luzon, and in freshwater lakes from the Philippines and off Sumatra. It is expected that many more are yet to be discovered.

SCOTTISH LAKE DWELLINGS*

FOR the first time one of the very numerous artificial islands on the Scottish lochs has been examined with a technical skill comparable to that so profitably expended on the crannogs of Somerset and more recently of Ireland. Fortunately, the engineers in charge of the Lochaber Water Power Scheme appreciated the scientific importance of the crannog in the north end of Loch Treig that the scheme had exposed and would destroy. Still more fortunately Prof. Ritchie, then at the University of Aberdeen, was able to take advantage of the opportunity for a thorough investigation of the island's structure.

The crannog proved to differ both in plan and construction from the Glastonbury lake village and the individual lacustrine habitations explored by Munro in Galloway last century and more recently by Hencken in Ireland. While the latter are round, it was rectangular. The basal structure was a framework of squared beams, 65 ft. by 42 ft., founded upon a bed of large stones that had been laid on a natural elevation in the loch floor. Above this, layers of timbers and, of earth and stones, each separated by layers of brushwood, birch-branches or heather, and in all nearly 6 ft. thick, supported an upper framework of undressed trunks 57 ft. long by 30 ft. broad. It supported yet another layer of brushwood, above which came the actual dwelling floors, frequently renewed until the total deposit above the upper platform was 3 ft. thick. The timber frameworks were kept in place by a double row of upright piles that the excavator shows cannot have served as a defensive palisade.

Access to the island was not provided by any causeway, but a landing stage was found from which a sloping ladder led up to the island's surface. The report emphasizes the structural importance of the brushwork layers both in distributing the weight of superstructures and in cementing together heterogeneous layers.

Ritchie argues convincingly that the usual accounts of the construction of such islands simply will not work with the Treig crannog, and concludes that its builders must have temporarily lowered the water-level at this end of the loch. Relics were disappointingly scarce. They confirm literary testimony to the occupation of the island in the sixteenth and seventeenth centuries, but nothing unambiguously distinctive of an earlier period was found, though a leather shoe seems to be derived from a Romano-British pattern, and the peculiar technique exemplified in a woollen fabric finds its nearest (but still not exact) parallel in textiles of the Viking Age.

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* "The Lake-dwelling or Crannog in Eadarloch, Loch Treig: its Traditions and its Construction", by James Ritchie. *Proc. Soc. Antiquaries Scot.*, 76, 8–78, with plates IV–XIX and 22 text-figures.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, November 28

Royal Photographic Society (at 16 Princes Gate, South Kensington, London, S.W.7), at 3 p.m.—Dr. S. O. Rawling: "Sensitometry since Hurter and Driffield" (Hurter and Driffield Memorial Lecture).

Monday, November 30

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. W. Allen: "Some Aspects of Insulation", 2: "Sound Insulation" (Cantor Lectures, 2).

Royal Society (at the Royal Institution, Albemarle Street, London, W.1), at 3 p.m.—Lectures in commemoration of the Tercentenary of the birth of Isaac Newton. Prof. E. N. da C. Andrade, F.R.S.: "Newton and the Science of his Age"; Rt. Hon. Lord Rayleigh, F.R.S.: "Newton as an Experimenter"; Sir James Jeans, O.M., F.R.S.: "Newton and the Science of To-day".

Tuesday, December 1

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 2 p.m.—Mr. J. K. Hunter and Mr. R. W. Mountain: "Hydro-Electric Development, some Economic Aspects".

Royal Institution (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. J. C. Drummond: "The History of our More Important Foods", (ii) "Meats".*

Wednesday, December 2

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. D. R. Bomford: "Agriculture To-day and To-morrow", 2: "Machinery in Modern Farming".

British Society for International Bibliography (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 2.15 p.m.—Mr. R. Unwin and Mr. M. C. Haycroft: "Cooperation between Authors and Printers in the Preparation of Copy for Publication".

Royal Entomological Society of London (joint meeting with the Genetical Society) (at 41 Queen's Gate, South Kensington, London, S.W.7), at 3 p.m.—"Methods of Study of Wild Populations" (Speakers: Dr. R. A. Fisher, F.R.S., Prof. Julian Huxley, F.R.S., Dr. C. B. Williams, Dr. George Salt, Prof. P. A. Buxton).

Thursday, December 3

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Lieut.-Colonel K. Edgcumbe: "Standardization as applied to Industrial Electrical Instruments".

Friday, December 4

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. William G. Holford: "The Small House and the Large Town, some Town Planning Problems".

Physical Society (in the Lecture Theatre of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 4.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: A lecture on Newton (in celebration of the Tercentenary of Newton's Birth).

Saturday, December 5—Sunday, December 6

Association of Scientific Workers (with the support of the British Association) (at Gas Industry House, 1 Grosvenor Place, London, S.W.1)—Conference on "Scientists of the United Nations and the War Effort".*

Saturday

At 2.30 p.m.—"Allied Scientists" (Chairman: Sir Richard Gregory, Bart., F.R.S.).

Sunday

At 11 a.m.—"Free National and Refugee Scientists" (Chairman: Prof. John Marrack).

At 2.30 p.m.—"British Scientists" (Chairman: Sir John Russell, F.R.S.).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (man or woman) for Chemistry and Physics, and a Lecturer for Engineering Subjects—The Principal, Shrewsbury Technical College, Shrewsbury.

Headmaster of Felsted School—The Clerk to the Governors, Mr. Norman Orfeur, Solicitor, Braintree, Essex (December 31).

Director of the National Froebel Foundation—The Secretary, National Froebel Foundation, 2 Manchester Square, London, W.1 (February 27).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Something to Look Forward To: a Suggestion for a New Social Contract. By Lady J. Rhys Williams. Pp. 54. (Cardiff: Western Mail and Echo, Ltd.) [1210

Six-Figure Trigonometrical Tables and Formulæ. Pp. 55. (Dagenham: Ford Motor Co., Ltd.) 1s. 6d. [1210

University of London: University College. Calendar, Session 1942-1943. Pp. xxv+126. (London: Taylor and Francis, Ltd.) [1310

The Atlantic Charter and Africa from an American Standpoint a Study by the Committee on Africa, the War, and Peace Aims. Th Application of the 'Eight Points' of the Charter to the Problems o Africa; and especially those related to the Welfare of the Africa People living South of the Sahara, with related material on Africa Conditions and Needs. Pp. xi+164. (New York: The African Bureau London: Edinburgh House Press.) 75 cents; 4s. [1310

British Rubber Producers' Research Association. Publication No 24: Thermodynamic Study of the Elastic Extension of Rubber. By L. R. G. Treloar. Pp. 6. Publication No. 25: The Interaction betwee Rubber and Liquids, 2: The Thermodynamical Basis of the Swellin and Solution of Rubber. By G. Gee. Pp. 8. Publication No. 26 (i) α-Methylenic Reactivity in Olefinic and Polyolefinic Systems, by E. H. Farmer; (ii) The Course and Mechanism of Autoxidatio Reactions in Olefinic and Polyolefinic Substances, including Rubbe by E. H. Farmer, G. F. Bloomfield, A. Sundralingam and D. A Sutton; (iii) Ionic and Radial Mechanisms in Olefinic Systems, wit special reference to Processes of Double-Bond Displacement, Vulcanisation and Photo Gelling, by E. H. Thomas. Pp. 24. (London British Rubber Producers' Research Association.) [141

The Post-War Home: a Series of Lectures on its Interior an Equipment. (Published for the Royal Society of Arts.) Pp. 120 (London: *The Studio*, Ltd.) 2s. 6d. net. [201

British Electrical and Allied Industries Research Association Technical Report, Reference W/T7: Simplified Electrically Heate Hotbeds. By C. A. Cameron Brown and E. W. Golding. Pp. 24 (London: British Electrical and Allied Industries Research Association.) 1s. net. [201

Ministry of Agriculture and Fisheries. Growmore Bulletin No. 7 Fruit from the Garden. By J. M. S. Potter. Pp. 13. (London: H.M Stationery Office.) 3d. net. [211

Geological Survey of Great Britain: Scotland. Wartime Pamphle No. 27: The Oil-Shales of the Lothians—Structure. Area 2: Pumpherston. By Dr. J. G. C. Anderson. Pp. 20. (London: Geological Surve and Museum.) 1s. [211

Other Countries

Bulletin of the American Museum of Natural History. Vol. 80 Art. 2: On the Structure of *Mesoplodon densirostris*, a Rare Beake Whale. By Henry C. Raven. Pp. 23–50. (New York: America Museum of Natural History.) [201

University of Cape Town. Communications from the School o African Studies, New Series No. 1: The Bored Stones of Souther Africa, Part 1: Bantu Specimens. By A. J. H. Goodwin. Pp. iv+22 (Cape Town: University of Cape Town.) 2s. [201

Nyasaland Protectorate. Annual Report of the Forestry Department for the Year ended 31st December 1941. Pp. 16. (Zomba Government Printer.) 1s. [201

Department of Public Instruction, Technical Education Branch New South Wales. Technological Museum: Curator's Annua Report for Year ended 31st December 1941. Pp. 2. (Sydney: Government Printer.) [201

Towards a New World-Order, an Indian View. An Address delivere to the Joint Easter Session of Science Associations in Bangalor April 4, 1942. By D. V. Gundappa. Pp. 32. (Bangalore: Karnatak Publishing House.) [221

Annual Report for the Year 1941 of the South African Institute fo Medical Research, Johannesburg. Pp. 56. (Johannesburg: Sout African Institute for Medical Research.) [221

Records of the Geological Survey of India. Vol. 75, Professiona Paper No. 16: Bauxite and Aluminous Laterite Occurrences i Jashpur State, Eastern States Agency. By A. K. Dey. Pp. ii+1 (Calcutta: Geological Survey of India.) 4 annas; 5d. [221

Indian Forest Records (New Series). Utilisation, Vol. 2, No. 7 Note on Indian Timbers for Aircraft and Gliders. By V. D. Limaye Pp. v+168–177. 4 annas; 5d. Silviculture, Vol. 5, No. 1: Th Problem of the Pure Teak Plantation. (A revision of Bulletin N 78 of 1932.) By M. V. Laurie and A. L. Griffith. Pp. ii+121+ plates. 3.10 rupees; 5s. 9d. (Delhi: Manager of Publications.) [221

Indian Forest Bulletin (Botany, New Series), No. 109: Hints fo Botanical Collectors. By M. B. Raizada. Pp. iii+9. (Delhi: Manag of Publications.) 2 annas; 3d. [221

Survey of India. General Report, 1941, from 1st October 1940 t 30th September 1941. Pp. vi+41. (Calcutta: Survey of India 1.8 rupees; 2s. 6d. [22

Harvard Meteorological Studies. No. 5: Eclipse Meteorology, wit Special Reference to the Total Solar Eclipse of August 31, 1932. B Charles F. Brooks, Sterling P. Fergusson, Herbert H. Kimball, Ber hard Haurwitz, Eleanor Stabler Brooks, Jerome Namias, Charles Pierce, Harry Wexler, Edward M. Brooks. Pp. 109. 1.25 dollar No. 6: Heat Transfer by Infrared Radiation in the Atmosphere. B Walter M. Elsasser; with a copy of the Atmospheric Radiation Char second edition. Pp. 107. 1.25 dollars. (Milton, Mass.: Blue H Meteorological Observatory.) [261

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Ban 19, No. 3: Det Stora Nordenskiöldska Järnblocket från Ovifal Mikrostruktur och Bildningsätt. Av H. Löfquist och C. Benedick Pp. 96+2 plates. Serien 3, Band 19, No. 4: Communities of Mari Algae in Subantarctic and Antarctic Waters. By C. Skottsberg. P 92+3 plates. Serien 3, Band 19, No. 5: Die Bothriolepis-Arten d Cellulosa-Mergel Lettlands. Von Walter Gross. Pp. 80+29 plate Serien 3, Band 19, No. 6: A Spectrophotometric Investigati on Stars in Bright and Dark Regions in Cepheus. By Gunnar Wer berg. Pp. 140. Serien 3, Band 19, No. 7: Die Hydracarinenfau Südbrasiliens und Paraguays, Teil 1. Von O. Lundblad. Pp. 184+ plates. Serien 3, Band 19, No. 8: Bau und Entwicklung der Gnetu Gametophyten. Von Folke Fagerlind. Pp. 55. Serien 3, Band 2 No. 1: General Morphology of the Lateral Sensory Line System the Head in Fish. By Nils Holmgren. Pp. 46. Serien 3, Band 2 No. 2: Die Hydrocarinenfauna Südbrasiliens und Paraguays, Teil Von O. Lundblad. Pp. 176+7 plates. (Stockholm: Almquist a Wiksells Boktryckeri A.-B.) [27

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SCIENCE AND THE WAR EFFORT

THE eighteenth report of the Select Committee on National Expenditure is concerned with 'a number of those questions relating to the scientific side of the war effort which were raised in the Select Committee's own eighth report on the organization of production, and which the new arrangements and appointments by the Minister of Production were designed to meet. The report is an acute analysis which, if it does not entirely dispel the anxieties of scientific workers, should assist to focus constructive criticism on the weak points of the present structure. It records the general impression that if the steps taken in recent months are properly followed up and the right men found to fill the key appointments, war efficiency should be improved in the vitally important matter of providing the Fighting Forces with the right weapons at the right time.

Considerations of public safety have limited the Committee to observations in general terms on the main principles of organization necessary and on specially important features in executive methods. In regard to the clarification of responsibilities, it is pointed out that the key questions are exactly where, under the new arrangements, the responsibility rests for formulating the Army's requirements and the manner in which the practical arrangements on the War Office side for formulating requirements link up with the arrangements on the Ministry of Supply side for converting these requirements into production of suitable weapons. On this it is observed that, while the answer to the first question is that the responsibility under the Secretary of State and the Chief of the Imperial General Staff is now centralized in the Deputy Chief of the Imperial General Staff, for practical purposes there must be a very clear understanding as to the nature of the responsibility carried by each of the officers, directorates or committees on which he relies.

In regard to the functional organization of research, design and production, the Committee points out that the conception of a unified functional organization requires application beyond the armoured fighting vehicles. Moreover, the Committee's realization of the vital importance of fully utilizing all available resources in the application of scientific research, technological skill and inventive intelligence to the production of improved new devices for fighting the enemy has led it to make a further inquiry into the organization on the Government side for handling the work of research, design and development. The observation that the success of new arrangements depends above all on the right men being chosen to fill the new posts as well as on the spirit in which Ministries and branches co-operate, for all its general applicability, should therefore not be taken as implying criticism of the three scientific advisers recently appointed to Mr. Lyttelton's staff to complete the organization for scientific research and development.

The main observations of this report deal with the relations between the Government organization and manufacturing industry. While research, development and detailed designing will now, so far as possible, be carried out by parent firms in full co-operation with the Ministry of Supply, the Committee suggests that in the design of instruments of war the responsibility for checking the battle-worthiness of a design and for ordering production to go ahead must always remain entirely with the Government authorities, as well as the responsibility for giving drive and urgency to the creation of a good technical design for a defined purpose. The responsibility for creating such a design, which involves individual qualities of originality and imagination, must on the other hand be handled in close contact with those who have to carry out the task of production.

The measure of responsibility that can properly be delegated to a private firm must largely depend on its character and organization. Normally, the combined responsibility for working out a design and for taking the lead in production as the parent firm of a group should be restricted to firms of stability and proved capacity, with substantial resources and good organization. Moreover, in regard to experience and resources, such close and confidential relations must be reciprocal, and all the technical data and results be placed at the disposal of the Government; there is an implied obligation to work essentially as part of the machinery of Government rather than in the spirit of private concerns. Sometimes the exchange of information and Government assistance appear to be haphazard, particularly when contracts are distributed among a number of firms with no previous experience in the operation of the necessary processes. Certain groups seem to be left without definite leadership, and in other cases where an individual engaged on Government research work may have found means to make contact with manufacturers, the value and extent of his assistance could be greatly increased by strengthening his own staff. The Committee recommends a systematic review of the working of the existing groups, and that the continuance of contact with such groups should be made the responsibility of a special officer or officers.

Scientific workers, while somewhat re-assured by the present report, will undoubtedly await with great interest the result of the further inquiry now proceeding. Reverting to the remark made above that the success of the new arrangements for scientific guidance made by the Minister of Supply (see NATURE, September 12, p. 301) depends on the right men being chosen for the key posts, the question of the position of Sir Stafford Cripps naturally arises. With his appointment as Minister of Aircraft Production, he has to bear the responsibilities of the administration of a Department of crucial importance in the struggle. Hence it is scarcely likely that he will be able to devote detailed attention to the activities of the new scientific advisers, and since he is no longer a member of the War Cabinet, he cannot present their views to those who are directing the War. Yet one of the reasons for welcoming the appointment of the three full-time scientific advisers to the Minister of Production was the further statement that they would "work under the immediate supervision of the Lord Privy Seal [Sir Stafford Cripps]" acting on behalf of the Minister. The position is not clear at present, and will be watched by scientific workers and others with keen attention.

CIVIL DEFENCE AGAINST WAR GASES

WAR has always been horrible. Axe and sword, lance and dagger gave way to gunpowder, though it did not entirely displace cold steel even in the Crimean war; to-day we depend largely on high explosives. During the War of 1914–18 there befell a new horror—chemical warfare, the use of poison gases—which shocked the world. When peace came, the nations solemnly renounced the use of gas at a Geneva conference, a pledge which has so far been kept—nor is there any reason why it should be broken. None the less, the defence against chemical warfare has to be ready. Thus everyone in Great Britain has a gas mask and knows how to use it and care for it. In addition, a highly organized and well-trained gas service has been brought into being, ready to function when required, though hopeful that enough of civilization remains to spare the world this particular horror.

The defence against gas has the advantage over the defence against high explosive or fire bombs that it can be complete. Knowledge of what to do and the ability to do it quickly can make the individual safe in the heaviest gas attack. The value and the efficiency of the general civilian and other official types of respirator cannot be too highly rated. These respirators will stop all the likely war gases and even the strongest concentrations which can be produced in the immediate vicinity of bombs out of doors. They will remain completely effective against lesser concentrations almost indefinitely. It is the duty of men of science to make clear to their lay friends that they can have complete confidence in their respirators.

The other danger to the public is that due to splashes of vesicant gases or prolonged exposure particularly of the eyes, to vapour from these. The area splashed by any one bomb is small, and in general the number of people likely to be splashed on its bursting will not be large. Should one become a casualty, the skin must be treated without delay with the ointment which has been prescribed for the purpose. In addition, should gas be used, chemists' shops will have pails of bleach cream ready for use by persons who may not have ointment immediately available. The clothing must be shed at once so as to prevent penetration of liquid and vapour to the skin. The Ministry of Health has made ample arrangements both for personal cleansing and for decontamination of clothing. Above all, it is important to keep the eyes shielded should a gas attack be feared.

The vapour danger from vesicant gases, which exists until the liquid in the streets has been destroyed, depends upon the concentration and the time of exposure. This danger is therefore also a function of temperature, which governs the concentration, and so is less at night. Under ordinary conditions the time required to produce blistering effects on the skin may be as much as an hour or more. There is, therefore, no need to run this risk by remaining so long in the vapour. Vesicant burns are highly undesirable wounds, but they can be largely avoided by the exercise of commonsense.

No branch of the national defence has been more fully or precisely documented than gas. The Government has enlisted the help of some of the ablest scientific men of the country to aid the official chemical defence organization in the preparation of a series of A.R.P. handbooks. These were ready from 1936 onwards and have, where necessary, been kept up to date by new editions. The information given in these represents the considered conclusions of many who have thoroughly studied the subject in a practical manner; the handbooks are cheap, and they form the basis of the instruction given to an increasing number of pupils in the A.R.P. training schools. Numerous books on the subject have also been published; at the best these are but copies in altered wording of the official handbooks and, where in them an author chooses to air his own views, he runs the risk of being at variance with those who have been in a position to make experiments.

A gas attack may have several consequences: it may injure the individual or contaminate his clothing and surroundings, or it may contaminate foodstuffs, rendering them unfit to eat. This last aspect is a special one, and in view of its importance and the need to prevent any waste of food, it has received full official appreciation and study. The problem involves recognition that a foodstuff may have been contaminated, a task performed by the Gas Identification Service; the determination of the degree and extent of the damage by the analyst; and the decision whether the material must be destroyed or can be decontaminated and made fit for consumption.

It is necessary and proper to create and train an organization ready to cope with gas-contaminated foodstuffs, however great the emergency. There is a tendency, however, in certain quarters to exaggerate this danger. It is highly unlikely that gases or vapours themselves will harm most foodstuffs, and since the majority of foods are stored inside buildings and are themselves in packages, splashing or liquid contamination is not likely to be a frequent occurrence. It is arsenical contamination which gives most cause for precautionary measures. It is possible that gas bombs may fall in water reservoirs. Such incidents have to be studied from the point of view of the volume of the reservoir in relation to the volume of the bomb, and may be regarded in general as of small significance in making water unpotable.

It is sometimes overlooked that any gas brought to Great Britain from a foreign country has to be carried in aeroplanes, which are limited in numbers and have a restricted load. Calculations which can readily be made indicate that the maximum possible amount of gas that can be dropped in a given time is very small in relation to the total volume of air over, and total extent of ground-space in, the area attacked. Hence its effect may be expected to be local rather than general, and limited in magnitude. There can be no such thing as a lake of gas persisting over a large area, or a whole city soaked in gas.

To-day the ordinary citizen has a good deal to think about and it may be unfair to expect that, while he regards the use of gas as improbable, he will take a keen interest in his personal defence against gas. There must be no slackening, however, in the effort to train the A.R.P. key men in gas defence, for it cannot be too strongly emphasized that a highly perfected defence against gas is the best means of ensuring that poison gas will not be used against our cities, since such an attack can then have little success. It is obviously impossible to do more than express the view that this work is being well done.

The problems confronting the authorities during and after a raid in any 'target area' are likely to be many and varied. It is to be supposed, for example, that gas bombs will be mixed indiscriminately with high explosive and incendiary bombs. The available resources, growing more scanty as the need for men for the Armed Forces gets more pressing, will have to be deployed to the best advantage, while those in the control rooms will need to be able to appreciate the significance of any happening and to take measures to allay panic and meet the situation. Gas being a weapon, unknown and unseen, may well cause panic unless men with the qualifications of the gas advisers and gas identification officers are available in the control centres and able to reduce the imaginary to the actual danger. The task of such officers is to correlate the mass of evidence from incoming reports, advise in regard to contradictions and anomalies, and generally keep the incident on a sane and sober basis.

The planning of exercises on a large scale is an important part of the training of the senio officers. All the different units concerned learn to know one another and to work together. Such exercises go beyond the actual attack by gas on the people and their homes; they comprise also the rescue of contaminated food, the making safe of streets splashed with mustard gas—an operation which can now be done in relatively few minutes—and the decontamination of the individual room in a house which has received a direct hit.

By such training and preparation, which are part of the normal experience of the Armed Forces, the civil population can be guarded against the effects, subjective as well as objective, of gas attack. Given effective protection, as scientific men will readily appreciate, gas attack can achieve little success; the knowledge that an adequate defence service against gas is in operation will be a major factor in deterring the enemy from using it.

MATRILINY IN INDIAN SOCIETY

Mother-right in India

By Baron Omar Rolf Ehrenfels. (Osmania University Series.) Pp. xi+229. (London: Oxford University Press, 1941.) 12*s.* 6*d.* net.

BARON EHRENFELS has undertaken an ambitious scheme in his analysis of mother-right in India, and that is no less than to investigate "the entire complex of problems grouped round the questions of the matriarchal system in India". The results at which he arrives are far-reaching. He concludes that in the south-west, if not in the main peninsula, of India there have been four strata of matrilineal peoples, while a fifth is to be found in the north-east. A map indicates the distribution all over India of more or less isolated features of these matrilineal cultures, which survive as complete and functioning matrilineal societies only on the Malabar coast in the south-west, and in the Khasia and Garo Hills in the north-east. To the influence of these matrilineal cultures of the past, of which traces only now survive in the greater part of India, Baron Ehrenfels attributes a very large number of past and present features of Indian society. Thus the efflorescence of Buddhist culture in the fifth, fourth and third centuries B.C., the practice of vegetarianism, the widespread, if socially despised, institution of the matrilocal marriage in which the son-in-law goes to live as a *ghar-jamai* in the house of his sonless father-in-law, and many familiar features of Rajput society past and present, such as the practice of *johar*, that is, the immolation of themselves by the women *en masse* when their men were defeated in warfare, and the continuing use of cattle in marriage processions, are all put down to the influence of the fourth matrilineal culture, which is held to have flourished at Mohenjodaro, while megalithic cultures, head-hunting, and the practice of sacrifice by decapitation, for example, are ascribed to an earlier and more primitive stratum of matriliny. Other institutions again, child-marriage, hypergamy, bride-prices, are directly ascribed to the clash of immigrant patrilineal with pre-established matrilineal cultures, while totemism is regarded as the pure product of a patrilineal age.

It can scarcely be said that the author makes an entirely convincing case for all this. Wide as his research has been, the very nature of the evidence is such that its interpretation can only rest on inference, and alternative hypotheses cannot be excluded. For one thing Baron Ehrenfels belongs emphatically to the *Kulturkreise* school of Schmidt and Graebner; Father Koppers, indeed, has written a preface to his volume. Not everyone will be willing to attach the same importance as that school attaches to migrations of peoples as the agents in spreading cultures, for it is easy to show that ideas, languages and social customs can be diffused no less widely than material culture without any movement of population. In any case an attempt to deal with Indian cultures on such lines ought not to have ignored, as Ehrenfels has done, the significant distribution of brachycephaly in India; and one may legitimately take exception to the use of the terms 'Aryan' and 'Dravidian', which are purely linguistic terms, as if they had a satisfactory racial significance. The essential continuity of traditional and popular Hinduism with the pre-Rigvedic religion of India has not been appreciated. This religion conquered that of the Rigvedic invaders and reduced their high god, Indra, to a mere door-keeper. Thus the Black Yajurveda prescribes the sacrifice of cattle to a number of Rigvedic deities, but not to Shiva, whose cult goes back to the Indus civilization; later the Aditya Purana prohibits the sacrifice of cattle "because certain noble and wise men did not practise it"; while a later authority still states that although their flesh may fitly be offered to Mitra and Varuna they should not be sacrificed, because the public detested it. Marshall's arbitrary distinction between the bull cult of Mohenjodaro and a cow cult ascribed to the 'Aryan' invaders has, of course, no sort of validity, and should not have been accepted. Ehrenfels follows Heine-Geldern in identifying the short-horned bull on the Indus seals with the gaur, an identification the reviewer is inclined to accept, but it must be pointed out that both Friederichs and Olver identify it with either *Bos primigenius* or *Bos namadicus*, Olver specifically rejecting any identification with *Bos gaurus*. There are some regrettable omissions in the material surveyed. The people of the Simla hills, and the Khasas and Hill Doms of the United Provinces, with their many survivals of matriliny and of the worship of snakes and a mother goddess do not appear at all, nor do a number of the Assam tribes, the Lakher in particular, which retain striking survivals from matrilineal cultures.

Whatever its defects, however, "Mother-right in India" is a work of much importance to Indologists, particularly in its suggestive ascriptions of so many features of Indian culture to a clash between an established and more or less civilized matrilineal society and an invading patrilineal one. In this respect Baron Ehrenfels has hit on an important and even fundamental element in the construction of Indian society as we know it now. The reviewer has himself suggested that the social grading of castes in the Laws of Manu has a similar origin. The offspring of a Brahman man and a woman of lower status may stand socially near the top of the list; that of a Brahman woman by a man of low caste comes at the very bottom. It seems likely that this scheme is the formalist interpretation at a later date of the conditions and traditions surviving from a time when the issue of a marriage between a patrilineal man and a matrilineal woman inherited status, if not property, from both sides, whereas the offspring of a patrilineal woman by a matrilineal man would have neither status nor inheritance on either side. The Brahman doctrine that the woman is a mere soil for the reception and nourishment of the seed of the man, to which she contributes nothing essential of her own, is the sort of simple and plausible idea that might easily appear to be the sudden revelation of a profound truth among uncritical peoples observing matrilineal customs without perhaps laying any particularly marked emphasis on the part played by the male in procreation, and one can imagine the spread of such an idea with devastatingly revolutionary effects on culture. It is perhaps rather to some phenomenon of this kind that we should look for an explanation of the inconsistencies of Indian culture patterns than to an application of the culture-strata theory of the Vienna school. But the material for study remains constant and much of it has been collected and collated for us by Baron Ehrenfels.

J. H. HUTTON.

MATERIALS FOR STUDENTS AND DESIGNERS

Strength of Materials

By Prof. S. Timoshenko. Second edition. Part 1: Elementary Theory and Problems. Pp. xiii+359. Part 2: Advanced Theory and Problems. Pp. xiii+510. (London: Macmillan and Co., Ltd., 1940–1941.) 2 vols., 50s. net.

IN 1938 a remarkable tribute was paid to Prof. Timoshenko on the occasion of his sixtieth birthday. Advantage was taken at the annual dinner of the American Society of Mechanical Engineers to honour him by a programme of appreciative speeches and to present to him a commemorative volume in which original articles, dealing with various aspects of the mechanics of solids, had been contributed by engineering and scientific friends each with an international reputation. It is not surprising, therefore, that text-books from Prof. Timoshenko should be welcomed by all interested in the progress of engineering learning.

The present review deals with the second edition of his now famous work on the strength of materials. This is divided into two volumes, the first of which is devoted very largely to the presentation of matter usually taught in engineering degree courses dealing with the strength of materials. For post-graduate students and research workers the second volume will be found particularly suitable, since it deals with those difficult features of engineering design and investigation which all engaged in engineering production must, at some time, inevitably encounter.

Although no great changes have been made in this second edition, yet where experience has shown that teaching requirements may be better met, modifications in the methods of presentation have been adopted and some of the more advanced work, originally contained in Part 1, has now been transferred to Part 2. In place of this advanced matter, a more extended treatment has been given in Part 1 to some of the problems previously expounded rather briefly, with the result that the student will now read these with greater understanding.

Space will permit of only a brief reference to the contents of these volumes, but some attention may be given to a few features. Thus the admirable arrangement of Chapter 1, dealing with tension and compression within the elastic limit, can be especially commended. Here the student is gradually led from the most elementary consideration of stress and strain up to the solution of quite difficult problems by a skilful blending of descriptive matter and excellent examples. In like manner, the method of dealing with the deflection of loaded beams calls for admiration. Commencing with the equation of the deflection curve, the usual integration method of determining deflection of cantilever and simply supported beams with different types of loading is first employed, and here again the arithmetical examples provided are particularly suitable. This is followed by illustration of the use of the bending moment diagram and the method of superposition, whereby the solution of difficult problems under complicated systems of loading and different methods of support can easily be effected. Later on, the elastic strain energy method is given and attention directed to considerations of the effect of shear. In all this fundamental work, the manner in which the student is conducted from the simple to the more complicated problem is a great tribute to the powers of Prof. Timoshenko as a teacher.

In Part 2, special attention is given to the later developments, both theoretical and experimental, of practical importance in the fields of strength of materials and theory of elasticity. Problems connected with aeroplane construction are considered under the investigations into the bending, compression and torsion of slender and thin-walled structures. A chapter is devoted to plastic deformation and another to experimental investigations on the behaviour of materials at high temperatures and to fatigue under conditions of stress reversal.

Although for much of the work in this volume a fairly high standard of mathematics is required, yet the author never omits to place the practical engineering considerations before the reader, and continual references are made to original papers on the subject under discussion. Thus, following the mathematical treatment of stresses produced by shrink fits, attention is directed to special articles dealing with experimental investigations into this class of engineering construction. It is suggested here that some mention might have been made of the work of Russell, who showed experimentally that the effectiveness of the shrink fit largely depends upon the surface cleanliness of the two mating elements.

One difficulty to British students will arise from the author's use of symbols which differ appreciably from those employed in our own text-books. In this second edition, changes have been made in the notation to conform with the requirements recently adopted by the American Society of Mechanical Engineers. It is to be hoped that it will not be long before a standard list of symbols will be drawn up which will be common to both countries.

WEATHER STUDY

Weather Study

By Prof. David Brunt. (Nelson's Aeroscience Manuals.) Pp. 216. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1942.) 5s. net.

WAR has always been very much at the mercy of the weather, and the advent of flying emphasized the dependence. Between 1914 and 1917, meteorology gradually came to be an essential part of the fighting organization, though the scientific side of the work was still in the hands of a relatively few professionals. In the present conflict some knowledge of the subject is essential, or at least helpful, to a large number of 'other ranks', while the number of civilians engaged on work in which the physical processes of weather are directly or indirectly involved must run into thousands in Great Britain alone. These men and women, mostly young and intelligent but with little specialized training, are eager to learn; yet the range of suitable text-books open to them is sadly limited. Hence Prof. Brunt's new semi-popular book, written explicitly for this class of reader—he mentions in particular Air Force Cadets and students of radio-location—is very welcome.

The emphasis on weather study has shifted very definitely from the descriptive to the analytical side, and especially to the physics of weather. The early meteorologists were for the most part content to explore and describe the facts in terms of averages and extremes of temperature, rainfall, etc.; the moderns seek to explain them in terms of air-masses, fronts and lapse-rates. But the physical meteorologist requires more rather than fewer observations, and the first requisite for the young meteorologist is a thorough knowledge of the instruments and methods of observation. This is the subject of Chapter 1, which might usefully have been twice the length. For example, although the units of pressure and temperature, and the various corrections to the barometer reading, are set out in some detail, the vernier is barely mentioned, and the reader is not warned at all against such errors as parallax. It would have been better to have given a definite reference in the text to the "Meteorological Observer's Handbook" rather than to leave it to the appendix, and for less ambitious readers, mention might be made of "Hints to Meteorological Observers". One cannot but feel that Prof. Brunt is not really interested in such mundane details, but is anxious to get on with the meteorology.

The rest of the book on the whole meets the criterion "not too little, not too much" very well. In Chapter 2 the author plunges boldly into what is probably the most general immediate cause of most weather phenomena, the diurnal variation of air temperature near the ground and its variation with height, with the corresponding phenomena of inversions and super-adiabatic lapse-rates, though adiabatic changes are not actually explained until a later chapter. Then follows a very brief account of world climatology, in which *causes* take wise precedence, the more striking facts only being used as examples (incidentally, the statement that in India the monsoon rainfall amounts "in places at times to several hundred inches within one month" might give an exaggerated impression; the two recorded instances of falls exceeding 300 in. in a month are both doubtful).

The core of the book is reached in the chapters dealing with the elementary physics of the atmosphere, including adiabatic changes of dry and saturated air, conditions in the upper air as represented by tephigrams and similar diagrams, the effects of radiation, and water vapour in the atmosphere. The remaining chapters consist of an introduction to the study of synoptic charts, decoding and plotting the observations, drawing the isobars and interpreting the charts in terms of gradient and upper winds and air masses. Depressions, both frontal and non-frontal, are described in some detail, but the account of thunderstorms is meagre; considering that the book is specifically dedicated to, among others, students of radio-location, one would have expected to find some reference to atmospherics, and even to the ionosphere.

On the whole, the book fulfils its purpose admirably. Though mildly mathematical in places, it is rarely difficult, and the more abstruse sections are well provided with clear diagrams. There are inevitably some blemishes; for example, the odd breaks in the diagram of relative humidity in relation to dry- and wet-bulb readings should have been explained as due to the coating of the wet-bulb with ice, and in the equations of change of pressure with height some confusion is caused by using *d* for the differential and for density in the same equation. Later, a curve stated to be the barograph curve of a sailplane flight is described as "rising or falling as the aircraft met rising or descending currents". These are minor points; more serious is the fact that the map of prevailing winds in July has suffered some sea-change and is about as wrong as it could be, showing, for example, sweeping *easterly* winds in the temperate latitudes of the southern hemisphere.

It is most unfortunate that lack of attention to detail and proof-reading should have marred what is in most respects an excellent book, for any reader who has dealt with it faithfully and written out answers to the test questions at the end of each chapter may fairly consider himself on the way to becoming a proficient meteorologist.

C. E. P. Brooks.

THE FALLING BIRTH-RATE

Parents Revolt

A Study of the Declining Birth-rate in Acquisitive Societies. By Richard and Kathleen Titmuss. Pp. 128. (London: Martin Secker and Warburg, Ltd., 1942.) 3*s*. 6*d*. net.

THIS book, which comes with a commendatory foreword by Beatrice Webb, is the work of writers well versed in the comparatively new but vigorous science of demography. As its title clearly intimates, however, its aim is not academic but practical. Demography has made rapid progress since the War of 1914–18. Its new and exciting discoveries, say the writers, though of vast importance to the future of man, are practically unknown to the general public. What the general public does know is that the practice of birth control, by means of devices for preventing conception, has spread from the well-to-do classes, among whom it arose in the closing decades of the nineteenth century, to the wage-earners. Long periods of unemployment and under-employment have been chiefly instrumental in causing the wage-earners to follow the example of their 'betters'. The authors give facts enough to show that we are now "between two biological worlds: one, the Age of Expanding Numbers, is dead; the other, the Age of Contracting Numbers, is just commencing". We are entering upon an unknown and a perilous period of our history. If, they affirm, the working people of Great Britain had during the past forty years returned the same birth-rate as the well-to-do, we should not have had sufficient man-power to wage the War—and money would not have saved us. Should it be objected that there is an element of guesswork in this statement, there is at any rate none in the next, which relates to the number of children in the school-group 5 to 14. In 1913 the number was upwards of seven millions, in 1938 only six millions. Assuming that the same conditions prevail, Dr. Enid Charles estimates the number as about four millions in 1950, and three millions in 1960. The authors refute in the strongest possible terms the suggestion that the falling birth-rate is due to the selfishness of parents, but their condemnation falls very heavily upon an economic system in which children seem to be simply not wanted. They recite an impressive array of facts to prove their point.

The authors' hope for a future which they aver is not necessarily gloomy lies in getting people to share Abraham Lincoln's belief in a time coming when "Money will cease to be master and become the servant of humanity". They point out that modern sanitation, social services, factory reforms and State education passed muster, not so much because they were right as because they would "pay"; and tha proposals for public works in relief of unemployment were argued only in terms of finance. They gibbet the May Report of 1931 which decided, for example, that Britain could not afford £1½ million a year for extended services to reduce maternal mortality—a sum we now spend in three hours of war.

This book is designed to help the common man to face the fact of revolution in reproduction, for in the long run, as the authors affirm in their final chapter, "The People Must Decide".

SCIENCE IN SOVIET RUSSIA

Science in Soviet Russia

By Seven British Scientists. Edited by Dr. Joseph Needham and Jane Sykes Davies. Pp. v+65. (London: Watts and Co., Ltd.; 1942.) 1*s.* 3*d.* net.

THIS little book provides a most useful glimpse of some of the scientific developments which have contributed towards the prodigious effort of defence by the Soviet Union in the present War.

The strength of science in the U.S.S.R. is based on its position in the official ideology. It is believed that a correct outlook on life and an adequate standard of living involves science as an integral part of all activities, spiritual and temporal. Hence science has been connected with every aspect of life, and its position in the Soviet State might be compared with that of the nervous system in man. As a result of these ideas, immense sums have been spent on laboratories and the training of scientific workers, and developments have been made according to plans. The scientific part of the new social order is in the main only fifteen to twenty years old. It has produced tens of thousands of new young scientific workers, many of them somewhat raw and not yet old enough in tradition to have highly developed scientific intuitions and critical judgments, but superb material for flying and artillery officers and factory management.

The events of the War have driven the chief Allied nations to create scientific organizations which grow more and more similar to the Soviet system of planned science. For this reason, as well as the bare facts, the seven essays in this book are of interest. Dr. Shoenberg's essay on physical research in the Soviet Union is outstanding. He speaks Russian, and has had the opportunity of working in Prof. P. Kapitza's laboratories in both Cambridge and Moscow. His comparative study of the two experiences is most illuminating. He says that the Moscow institute is several times larger, and has pleasant grounds. It has a staff of sixty people, compared with ten in the Mond Laboratory. For each physicist in the Soviet laboratory there are ten other employees, while at Cambridge there is only one. Half of the sixty are janitors, charwomen, chauffeurs, boilermen, gardeners, etc. Ten are office workers, and there was a good deal of 'red tape'. The ratio of mechanics and technicians to physicists was about four times as great as in England. Dr. Shoenberg found this a real boon. They were first-rate craftsmen, and so released much more of the physicist's time for attention to real physical problems.

Another attractive feature is that the research worker belongs to a particularly respected profession, and is not liable, as in pre-war England, to be asked: "But what do you do for a living?"

Dr. Ruhemann writes on industrial research from his six years' experience at Kharkov, Dr. Needham reviews work in biology, Dr. Walton agricultural research, Mr. Roscoe Clarke developments in medicine, and Dr. G. W. Tyrrell the growth of geology and mineralogy.

It is all informative, and is very reasonably priced.

J. G. CROWTHER.

LINEAR DIFFERENTIAL EQUATIONS

Operational Methods in Applied Mathematics

By Prof. H. S. Carslaw and J. C. Jaeger. Pp. xvi+264. (Oxford: Clarendon Press; London: Oxford University Press, 1941.) 17*s.* 6*d.* net.

A WAY to solve linear differential equations by operational methods which avoid the introduction of arbitrary constants by taking direct account of the initial conditions was invented by Oliver Heaviside (1850–1925) for the purpose of discussing electromagnetic waves. In his hands the method led to correct results, but the mathematical foundation was so obscure as to cause it to be regarded with misgiving. Bromwich (1875–1930) was the first to explain Heaviside's method, and, by expressing the solution in the form of a contour integral, to justify its application to ordinary linear equations. Since then many systems, modifications and expositions of varying degrees of merit have appeared.

The present work is based on the application of the Laplace transform

$$\bar{x}(p) = \int_0^\infty e^{-pt} x dt,$$

where p is a positive number sufficiently large to ensure the convergence of the integral and x is a given function of t. Thus, if $x = e^{at}$, $\bar{x}(p) = 1/(p-a)$. To take a very simple illustration, consider the equation $dx/dt + 3x = e^{-2t}$, given that $x = 0$ when $t = 0$. Multiply by e^{-pt} and integrate from 0 to ∞. This gives:

$$\bar{x}(p) = \int_0^\infty e^{-pt} x dt = \frac{1}{p+2} - \frac{1}{p+3},$$

so that $x = e^{-2t} - e^{-3t}$.

It will be seen from the above that the solution is inferred by writing down the function x whose Laplace transform is given, that is, by inverting the transform. In simple cases this can be done by inspecting a list or dictionary of transforms (such a list is given at the end of the book). When inspection fails, the inversion can be effected by a general theorem which expresses x as a contour integral when $\bar{x}(p)$ is given. Thus the method is direct, simple to apply and easy to understand.

The book contains three purely mathematical chapters on the application of the Laplace transform to linear equations with constant coefficients, on the inversion theorem, and on linear partial differential equations. The remaining seven chapters, each complete in itself, discuss a varied and interesting collection of problems in electric circuit theory, dynamics, conduction of heat, vibrations of continuous systems, hydrodynamics, electric transmission lines, electric waves. There are also numerous exercises for the student.

The book is well written, well printed, and can be recommended unreservedly to all who have to make scientific applications of linear differential equations.

L. M. MILNE-THOMSON.

MEASUREMENT OF ELECTRONIC CHARGE

By PROF. T. H. LABY, F.R.S.
University of Melbourne

Oil Drop Method

THE steps in the progress towards precision in the measurement of the electronic charge, e, are well known. The first measurements by J. S. Townsend and J. J. Thomson of 1897 and 1898 were approximate ones. H. A. Wilson in 1903 used a method new in principle, but it was not until Millikan and his many co-workers had completed their comprehensive investigations of the oil drop method and the viscosity of air that e became known with precision.

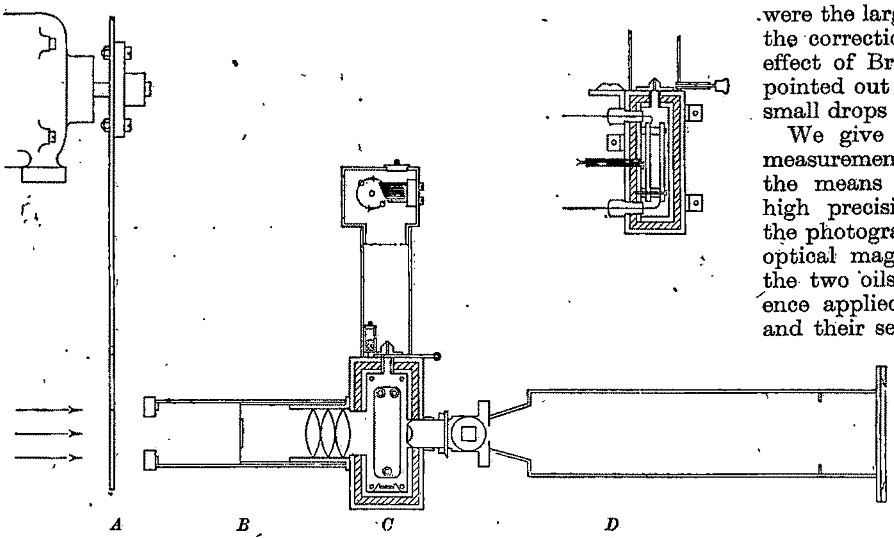

Fig. 1.* SKETCH OF APPARATUS.
A, rotating disk, which allows intermittent entry of light into the optical system.
B, optical system arranged to produce dark-ground illumination.
C, deflecting plates in central chamber arranged vertically so that drops are horizontally deflected by the electric field.
D, camera for photographing image of drops.
Brush for producing oil drops of suitable size is at the top of chamber shown vertically above condenser plates. On the right is a side-view of condenser plates.

*Figs. 1 and 2 are from a paper by V. D. Hopper and T. H. Laby in *Proc. Roy. Soc.*, A, 178.

Millikan's final value was accepted for a number of years without, if not as beyond, criticism until measurements by the X-ray method gave values as high as $4{\cdot}805 \times 10^{-10}$ E.S.U. for the electronic charge; this was greater than his value, $4{\cdot}774 \times 10^{-10}$ E.S.U., by many times the estimated probable errors of both. Some writers then raised the question whether the drop method was comparable in precision with the X-ray one.

There are several other methods of measuring e, as for example the α-ray one, but apparently none of them are precision ones.

Mr. V. D. Hopper and I[1] have determined e by means of a modified oil drop method, similar to H. A. Wilson's, but differing from it in that the electric field acts in a horizontal direction and not vertically. The drop describes vertical and inclined straight line paths.

The expression giving the uncorrected electronic charge, e_1, is

$$Xne_1 = 9\sqrt{2}\pi\eta^{3/2}(\rho-\sigma)^{-\frac{1}{2}} g^{-\frac{1}{2}} v_g^{\frac{1}{2}} v_x,$$

where n is integral, v_g is the free fall and v_x is the velocity of the drop in the direction of the electric field X. The relation

$$e_1^{2/3} = e_0^{2/3} + m/pa$$

corrects e_1 for departure from Stokes's law, where a cm. is the radius of the drop, and p cm. of mercury is the air pressure. The oil drops were photographed (at intervals of 1/25 sec. using a 1/1,500 sec. exposure) to eliminate subjective timing errors, and disturbing effects of the light beam.

Observers	$e_0 \times 10^{10}$	$m \times 10^3$
Authors	$4{\cdot}802\,0 \pm 0{\cdot}001\,3$	$0{\cdot}037\,7_7 \pm 0{\cdot}000\,4$
Millikan	$4{\cdot}799\,2 \pm 0{\cdot}003\,7$	$0{\cdot}037\,8_4 \pm 0{\cdot}000\,1$
Bäcklin and Flemberg	$4{\cdot}781\,1 \pm 0{\cdot}018$	$0{\cdot}037\,2 \pm 0{\cdot}001\,4$
Ishida *et al.*	$4{\cdot}835\,0$	$0{\cdot}036\,1$

We used large drops (eight of them were the largest so far used) to decrease the correction to Stokes's law, and the effect of Brownian motion. As Perrin pointed out many years ago, the use of small drops invalidates the method.

We give full details of the actual measurement made in our paper, and the means adopted to measure with high precision the distances between the photographic images of a drop, the optical magnification, the densities of the two oils used, the potential difference applied to the condenser plates and their separation. The values of e_0 and m with their errors are given in the table above.

The probable errors are calculated from internal consistency by means of a least square formula quoted by Birge in one of his valuable discussions of least square theory. It is evident that the oil drop methods used by us and by Millikan give values for e and m in close agreement.

In calculating e we have used in the table above $\eta_{23} = 1{\cdot}83006 \times 10^{-4}$. Since η enters as $\eta^{3/2}$ in the expression for e, the value assumed for η as being the most probable is very important. We have critically examined nine recent measurements of η for air and derived a mean value. The error of the mean, $\pm 0{\cdot}0025 \times 10^{-4}$, is several times larger than the error of the more accurate of these values as estimated by internal consistency. There is this and other evidence that measurements of the viscosity of gases are subject to large systematic errors. The error in η mentioned contributes an error of 1 in 500 to e, and is now its main error by the drop method.

X-ray Method

In the X-ray method the lattice spacing, d cm., of a crystal is measured, and $e = 2d^3\,\phi(\beta)\,\rho F/M$, where $d^3\,\phi(\beta)\,\rho$ is the mass of the crystal molecule, M its molecular weight, and F the Faraday. This is done in several steps. First the wave-length, λ_g cm., of an X-ray line is measured. For example, the K doublet of aluminium was measured absolutely by Bäcklin using ruled gratings, and Söderman and Tyrén[2], using concave gratings, compared the aluminium line in

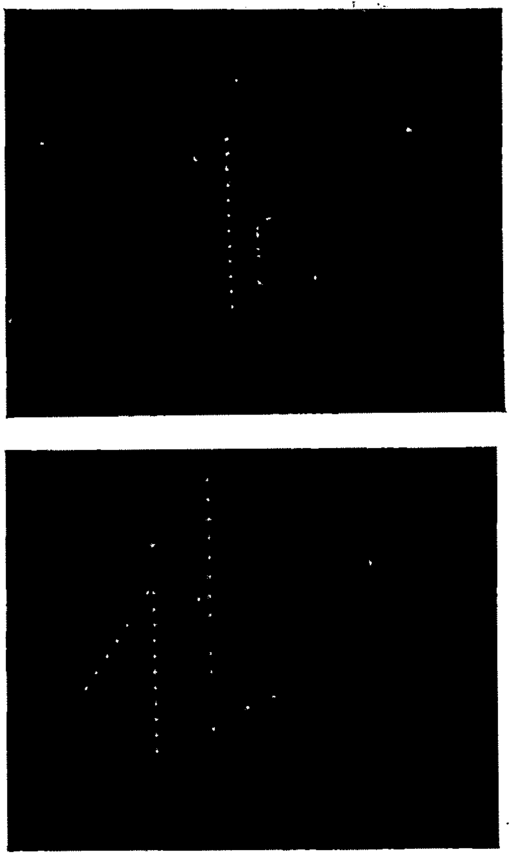

FIG. 2. PHOTOGRAPHS SHOWING PATHS OF DROPS BEFORE AND AFTER THE APPLICATION OF THE ELECTRIC FIELD.

Time interval between the appearance of consecutive images is 0·04 sec. Time of exposure for each image 0·0007 sec. Magnification of camera, × 12.

high orders with optical lines of the spark spectra of carbon, oxygen, etc., the wave-lengths of which Edlén had measured.

Next the wave-length of the X-ray line, λ_c x.u., is measured using an X-ray spectrometer and a crystal. Since for calcite λ_c Al $K\alpha_{12}$ is greater than $2d$, it cannot be used as the crystal. Mica, gypsum, and quartz crystals have been used. The lattice constant of the crystal used is compared with that of calcite using copper $K\alpha_1$ or other homogeneous radiation. The observations of Larsson, Siegbahn and Haglund agree closely, giving λ_c Al $K\alpha_{12} = 8322{\cdot}90$, where, as defined by Siegbahn (and always used by him), 1 x.u. = d_{18} calcite/3029·45.

The expression $e = (\lambda_g/\lambda_c)^3\ 4{\cdot}77302 \times 10^{-10}$ is used to calculate e; it is calculated using the most probable values of ρ, $\phi(\beta)$, F and M.

X-RAY VALUES OF *e*

Bäcklin	$4{\cdot}8017 \times 10^{-10}$	Tyrén	4·8020
Söderman	$4{\cdot}8027 \times 10^{-10}$	Bearden (1935)	4·8029

Mean X-ray value $(4{\cdot}8023 \pm 0{\cdot}001)\ 10^{-10}$ E.S.U.

If $\eta_{23} = 1{\cdot}8301 \times 10^{-4}$, the values of e are: Millikan, 4·799; Hopper and Laby, 4·8020; X-ray value, $4{\cdot}8023 \times 10^{-10}$ E.S.U., and the two methods agree.

Hopper, V. D., and Laby, T. H., *Proc. Roy. Soc.*, A, **178**, 243 (1941).

Tyrén, F., *Z. Phys.*, **109**, 722 (1938).

For reference to other workers mentioned in this paper see reference [illegible]).

GEOLOGY IN CHINA

ANNIVERSARY OF THE GEOLOGICAL SOCIETY OF CHINA

TO say that the activities of Chinese geologists during the past few decades have been remarkable seems almost an understatement: our admiration of their achievements is quickened by the reflection that the Geological Society of China was founded only twenty years ago. Even under the handicap of present conditions, the Society recently celebrated its twentieth anniversary, when Dr. J. S. Lee, as chairman, delivered an inspiring address. We in Great Britain feel gratified when we remember that Dr. Lee is one of the many Chinese geologists trained in a British university (in this case, Birmingham), and we look forward to a resumption and even an extension of this practice after the War. By this means we make close scientific contacts (which benefit those who give no less than those who take) with a country vast in area, varied in physical features and diversified in rock-types.

In China we see a part of the earth's crust where geological processes have been developed on the grand scale. Although geological history cannot actually repeat itself anywhere, we can usually detect recurrent phases that show mimetic resemblances. Moreover, it would seem that although the principles of geological science are by their very nature applicable to all terrestrial areas, each major unit of the continental surface displays its own peculiar features. For example, the surprising geological discoveries made year by year in Africa remind us that, so early as Pliny's time, men were accustomed to look to Africa for things always new. Since then, North America, India and the U.S.S.R. have produced their crops of geological novelties; and now we can appropriately apply to China the well-worn aphorism. Even the popular imagination is stirred by such events as the unearthing of fossil dinosaur eggs or the skull of Peking man, but these discoveries are matched by no less remarkable, if more esoteric, discoveries in the fields of mineralogy, palæontology, stratigraphy and tectonics.

The two decades that have elapsed since the foundation of the Geological Society of China have seen great political upheavals in the country, the setbacks due to ideological rivalries and a bitter war of penetration arising out of the economic ambitions of a neighbouring power. Such conditions are certainly not favourable for the prosecution of scientific work, and we cannot but marvel at the way in which our Chinese colleagues have succeeded in carrying on both laboratory research and the primary survey of the rocks of their motherland in spite of manifold difficulties, of which transportation is not the least considerable.

Dr. Lee's review of progress in Chinese geology during the past twenty years is a timely reminder of what can be accomplished in adverse circumstances by devotion to science: it is also a stocktaking which serves to indicate those fields in which more knowledge is urgently needed. At the outset, he directed attention to the "extraordinary fact" (to quote his own words) ". . . how few is the number of papers dealing with the economic aspect of geology that appeared in the bulletin of this society. Among the reasons to account for this record, I would point out one: namely, that a non-utilitarian tendency has always constituted a strong trait in the character of Chinese intelligenzia throughout historical times".

The misuse of scientific discoveries and the perverted developments elsewhere lead him to the reflection that (as he puts it) handicaps such as those due to the absence in a country of any legacy of geological ideas sometimes turn out to be an advantage. The contrast in outlook is emphasized by the action of the covetous neighbour who has invaded China in order to exploit the natural resources, especially of minerals. Comparatively little is known about the potentialities of the huge area of China which, *sensu lato*, covers more than one tenth of the earth's land surface: their proper assessment will inevitably call for a large army of investigators, and the information thus acquired will materially affect any action taken to implement the Fourth Article of the Atlantic Charter.

Dr. Lee notes that the Geological Society of China, although a national organization, is in fact international in character, as witnessed by the roll of members, who come from all lands. Many have participated in the work of the Society and are welcomed in a fraternal atmosphere. As he pointedly says, "we have even adopted the leading Western languages, principally English, as the official means of communication, not without some sacrifice of our own convenience". For this, as also for the fact that he gave his address in English, we are very thankful.

Some of Dr. Lee's animadversions are in the nature of warnings to his geological colleagues not to rely too much on the range of fossils and on stratigraphical divisions established in other parts of the world. He cites as examples the discovery of the tabulate coral Tetrapora, formerly believed to be typically Permian, in beds so ancient as the Lower Carboniferous; of a species of Sphenophyllum hitherto unknown below the Stephanian coal measures of Europe, in the Wuntung Sandstone of Lower Carboniferous age; and of the Upper Devonian fish Bothriolepis in the lower part of the Middle Devonian. He mentions other instances in order to show that the stratigraphical value and zonal positions of fossils in China are not in conformity with records established elsewhere. There are considerable lacunæ, he says, in the fields of mineralogy and petrology, such as the study of the constituents of the sedimentary deposits and the natural history of the igneous and metamorphic rocks of China. Both merit further attention, and his country offers generous scope for these lines of inquiry.

The survey of complex petrological provinces has necessarily proceeded slowly and map-making has been delayed, a fact which reminds Dr. Lee to mention incidentally the appearance of a gorgeously coloured geological map of Southern China, published by a foreign institution (and we can make a shrewd guess at its source, knowing which nation specialized in such regional activities) at a time when even the larger units of the stratigraphy were scarcely known! But, as he says, the absence of authoritative geological maps of China invites such "indignities".

After dealing with the subject of mapping, Dr. Lee is led to a discussion of problems of palæogeography, and he takes the opportunity to warn his colleagues against the danger of inferring the onset of important earth-movements from evidence which denotes non-sequence rather than major unconformity. As a prelude to the discussion of geophysical phenomena and tectonics, he describes examples of rock deformations that may astonish Western workers, such as the yielding of tombstones under their own weight and of the bending of pebbles of chert and hard sandstone under a load of ice only 100 m. in thickness.

Dr. Lee's early attempts to classify the structural features and mountain forms of China are well known to us, for they found publicity in an English geological journal. In his view, these features fall into three dominant groups, the Cathaysian and Neo-Cathaysian trends (the former dating from the Palæozoic and generally running north-eastwards, and the latter probably late Mesozoic and running north-north-eastwards), the east-west fold-zones, and the various shear-forms. The dominant shear-forms, five or six in number, are of his epsilon-type and each extends over the whole or part of a segment of the continent and is separated from the other by fold zones, their arcuate convex fronts facing the equator. Dr. Lee sees this structure also in the sweep of the Eurasian arcs, combined with the backbone of the Urals, and suggests that a similar arrangement can be found in North America. From experimental results in the laboratory, he infers that these features are characteristic of the behaviour of a plasto-elastic material when subjected to stresses, and that in the earth's crust they result from "the horizontal component of the centrifugal force arising from the spin of the earth, or more probably from an increase of its rotational speed". Dr. Lee admits that his generalizations are likely to arouse scepticism in some quarters. He makes reference also to a rather better known effect of the earth's rotation when he records that, like the meridionally flowing rivers of Russia, the mighty Yangtze is at the present time undercutting steeply its right-hand bank after it leaves the gorges

Dr. Lee concludes his address with a summary of the evidence for a polyphase Ice Age in China, in which there were not less than three separate glacial episodes. Incidentally, he correlates one with the "Würm of Europe": now, the Würm episode in the Alps is generally known, but opinions differ widely about the particular phenomena that distinguish its traces elsewhere.

Although only a few of its many interesting points can be mentioned here, we may take this opportunity to hail the address as contributory evidence of the virility of young China.

P. G. H. Boswell.

ELECTRON LENSES[*]

By Dr. D. GABOR

Research Laboratory of The British Thomson Houston Co. Ltd., Rugby

As soon as H. Busch had established the analogy between axially symmetrical electromagnetic fields and optical lenses, a question very naturally suggested itself: "Can we make electron lenses as perfect as the highly corrected lenses of modern optics?"

Compared with light optics the new science started with a great advantage, and with a great disadvantage. Whereas in optical instruments the ratio of refractive indexes never exceeds 2 : 1, in electronic devices we can realize ratios of 1000 : 1 or more, by using sufficiently high accelerating voltages. Against this stood the great disadvantage that while modern applied optics has a great variety of glasses at its disposal, with a wide range of chromatic dispersivities, electron optics has only two media, the electric and the magnetic fields, both with fixed properties. Nor can we shape the electron lenses as freely as the optician figures his surfaces, as we are limited by the conditions of zero divergence for the electric field, and zero curl for the magnetic field (freedom from space charges and space currents).

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[*] Substance of part of a lecture on "Electron Optics" before the Electronics Group of the Institute of Physics delivered on October 3. The complete lecture is being published in *Electronic Engineering*.

It will be useful to sum up in advance the position as it is now, after fifteen years of theoretical and experimental research. It was *not* possible in theoretical electron optics to design perfect or at least highly corrected lenses of high power. The initial disadvantage proved too great. On the other hand, the electron optical art could solve all its immediate problems by availing itself of the great inherent advantages of electron optics, by the use of *high voltages*. Almost the only service theory could render was to point out the unavoidable limitations, thus saving the workers from wasting time and energy on *perpetuum mobili*.

The first question which arose was: "Can an electron lens form a point image of a point on its axis?" Two defects are possible, due to spherical and 'chromatic' aberration. O. Scherzer demonstrated in an important paper[1] that neither can be eliminated. These two fundamental weaknesses of electron optics are closely connected with the impossibility of realizing diverging electron lenses under the conditions required by present-day practice, namely, zero space charge, and zero electric field both in the object and in the image space. In principle, the spherical aberration could be corrected by suitably controlled auxiliary streams of ions or electrons. But so far, experimenters have not been tempted to follow this line, which is bristling with difficulties. It may be asked whether the space charge of the electrons themselves which forms the image could not be used for this purpose? In fact, a perfectly stigmatic beam carrying a finite current density is not in principle impossible*, as the electrostatic energy stored in it is finite. It may even be surmised that this method of compensation has been unwittingly but successfully utilized in many cathode ray tubes. But it is useless in electron microscopes. A hint regarding these came from R. Rebsch[2]. Though the spherical aberration can never be quite eliminated, it can be reduced below any limit, if the field of the objective is so shaped that it forms a very small, very weak 'prefix lens' extremely close to the object. But to realize this requires extreme mechanical precision, and there is no evidence that practice had availed itself of Rebsch's suggestion.

When it was discovered in 1936[3] that *electron mirrors* had chromatic errors of opposite sign to those of lenses, it seemed that there was hope of correcting for chromatic aberration. But this was a forlorn hope, for several reasons. In mirrors, the image field will cut out the paraxial rays, and correction to a very high order becomes necessary, or the mirror has to be placed in a skew position to the axis, and all the formidable difficulties of non-centred optical systems have to be faced, which even in light optics have only partially and recently been overcome. But apart from these theoretical difficulties, electron mirrors offend badly against what I should like to call the first principle of *practical* electron optics: 'Do not slow down your electrons more than you can help".

I do not know whether this principle has ever been formulated, but the whole development of the electron optical art proves that it has been understood and observed. In fact, it is a very common experience in electron optics that electrostatic systems show performances far below theoretical expectations, and display defects far worse than could be accounted for by the geometrical inaccuracy of the electrode arrangement. The reason is that the electrode surfaces are often covered with what may be called somewhat vaguely *polarization layers*, which are often distributed in a patchy, irregular way, and can produce, between the surface and the body of the electrode, potential differences of several volts, sometimes even more than a hundred volts. So far as I know, they have never been systematically studied. Indeed, they present a rather typical case of a problem which is likely to be neglected. Academic circles cannot be expected to be interested in them, as they are far off the main road of progress. Industrial physicists have no time for this sort of problem; they will remove the difficulty by some *ad hoc* solution, or pass in a wide circle around it. But until the polarization layers are eliminated, all electrostatic systems using slow electrons are likely to be disappointing, and this is particularly true of electron mirrors.

Though, as we have seen, theory was not very helpful, electron optical practice has achieved brilliant successes. I have already mentioned the simple panacea of practice: *high voltage*. No high-power lenses were possible, but there was no need for them, because with sufficiently high voltages very much greater intensities† could be realized with electrons than with light. Moreover, the de Broglie wave-length of high-velocity electrons is very much shorter than the wave-length of visible light, so that, for example, at 60,000 volts the numerical aperture of an electron microscope could be cut down to 1/1000, and yet a hundred times higher resolving power could be realized than with a light microscope of unit numerical aperture.

With such narrow apertures even the aberrations of entirely uncorrected lenses become negligible, with the exception of the chromatic aberration. For this, however, practice had the simple remedy of monochromatic illumination, the electron optical translation of which is *constant voltage*. In the new commercial electron microscope of the RCA[4], the supply of 60,000 volts is kept constant within ± 1·2 volts, that is, 0·004 per cent, which means that the de Broglie wave-length of the electrons varies only by 0·002 per cent. In comparison, a sodium lamp is a very poor monochromatic source, as the two *D*-lines differ by 0·1 per cent, which is fifty times more. This almost perfect monochromatism is somewhat disturbed by the scattering in the specimen. But here again high voltage proves its claim as a panacea. The faster the electron, the less energy will it lose in a single collision, and if the specimen is sufficiently thin, the inhomogeneity of a 60-kv. beam emerging from it will be almost negligible, while the scattering (change of direction without appreciable difference in energy) is still sufficient to provide good photographic contrasts. Thicker specimens have been successfully investigated with 300-kv. electrons[5].

To sum up, practice has not waited for highly corrected lenses, but short-circuited the problem by pinhole apertures and monochromatic illumination. It appears even that further progress at the moment is not barred by lens imperfections, but by the polarization layers which form especially in the objective aperture[6]. This is one more reason for taking up their study in earnest.

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* Strictly speaking, not *optically* impossible. For thermodynamic reasons a rigorously stigmatic beam can never be realized.

† Intensity is energy flux per unit area and per unit solid angle.

Years ago, when highly corrected lenses appeared more important than at the present time, I often thought that it would be desirable to know the fields corresponding to *ideally stigmatic lenses*, regardless of the difficulty of their realization by current laboratory methods. After labouring on the problem without success for some time, I dismissed it from my mind, but recently when I again gave attention to the subject I found a very simple way leading to the solution. Though the result itself may not be of practical importance at the present stage of electron optics, I think that the method by which it is derived may be of interest.

Hamilton's Principle can be expressed in a form identical with Fermat's Principle

$$\int n.ds = \text{minimum},$$

where ds is an element of the trajectory and n is the electron optical refractive index. Let us apply this to the trajectories in the meridian plane of a lens. In this case n is independent of the direction, not only in electrostatic lenses, but also in the magnetic type, if we allow for the rotation of the trajectory around the axis.

Let us now map the meridian plane of the lens on a suitably chosen surface by a transformation

$$n.ds = dS,$$

where dS is the line element on the surface corresponding to ds. As n is isotropic, the transformation is *isomorphic*. A surface on which the meridian plane of the lens can be mapped in this way may be called a geodetic surface, as every electron trajectory will be mapped on it as a geodetic line[7].

This leads straight to the 'ideal lens', as it is obvious that *the geodetic surface of an ideal lens must be a sphere*. On a sphere the geodetics are great circles, and the great circles running through *any* point intersect again in its antipole, which can be considered as the rigorous image of the point considered. We can now map the sphere on a plane by *any* isomorphic projection known in cartography, and obtain an *ideal two-dimensional lens*. In order to obtain the ideal three-dimensional lens we choose the stereographic projection, on account of its central symmetry. This gives the following law for the distribution of the refractive index as a function of the radius vector r in the meridian plane:

$$n/n_0 = (1 + r^2/r_0{}^2)^{-1},$$

where n_0 is the refractive index at the centre, and r_0 a length which characterizes the dimensions of the lens. If we imagine this distribution rotated round any axis, we obtain the ideal three-dimensional lens. Because of its spherical symmetry, any trajectory will be contained in a meridian plane. The trajectories are one and all *ellipses*. An image of any point at a distance r_1 from the centre will be formed rigorously at a point on the same diameter at a distance r_2, and the simple relation between the two is

$$r_1.r_2 = r_0{}^2.$$

Image formation is therefore the geometrical transformation known as *inversion*. It can be proved that the three-dimensional ideal lens is unique. If there were other ideal lenses, they could be derived from the one described by isomorphic transformations. But according to a theorem of Liouville the group of isomorphic transformations in three dimensions is identical with the group of inversions, and according to a theorem of Cayley and Klein the group of inversions represents, by stereographic transformations, the rotations of a sphere on itself. As rotations of the geodetic sphere on itself are irrelevant, the ideal lens is transformed into itself, and is therefore unique.

Though it may be satisfactory to know that the ideal lens exists in the mathematical sense of 'existence', no immediate practical application can be expected, as it cannot be realized without space charges. The same is true of the infinite number of two-dimensional (cylindrical) ideal lenses, though some of these may be capable of approximate realization. These are all derivable from the 'stereographic' distribution by any conformal representation in which the action is kept invariant:

$$n.ds = n'.ds'.$$

It may be hoped that such representations will have other, less ambitious but more immediately fruitful applications, as they allow the transformation of one electron optical problem into another, and may even hold the key to certain space-charge problems, for which no satisfactory mathematical treatment has yet been found.

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[2] Rebsch, R., *Ann. Phys.*, 5, **31**, 551 (1938).

[3] Hottenroth, C., *Z. Phys.*, **103**, 460 (1936). Recknagel, A., *Z. tech. Phys.*, **17**, 643 (1936).

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[5] Zworykin, V. K., Hillier, J., and Vance, A. W., *J. App. Phys.*, **12**, 738 (1941).

[6] Hillier and Vance, *J. App. Phys.*, **12**, 171 (1941).

[7] Schrödinger, E., *Ann. Phys.*, **4**, 79, 489 (1926). Whittaker, "Analytical Dynamics", 4th ed., p. 254.

HEALTH EDUCATION IN GREAT BRITAIN

MANY of the most important institutions in Great Britain have, like Topsy, 'just growed', and among them is the Central Council for Health Education. Set up originally in 1927 as an offshoot of the Society of Medical Officers of Health, it has grown until it is now recognized by the Government as "the one agency for general health education in England and Wales", with thirty-nine members on staff and fifty-four active recognized lecturers. Since the Council, at the instigation of the Ministry of Health, took over in April of this year the major part of the work previously carried out by the British Social Hygiene Council, together with most of the staff responsible for it, its activities have increased enormously. The Council has regional offices in various parts of the country, which facilitates work considerably, and encourages local initiative.

The general public is probably most familiar with the Council's poster advertisement—indeed "Coughs and Sneezes spread Diseases" has become a nationa slogan. Posters are available for the use of loca authorities in sufficient diversity to cover most con ceivable needs. The disease-spreading proclivities of the rat and the fly; the life-histories of the bug the louse and the scabies mite; the importance of diphtheria immunization and whooping-cough inocu lation; the desirability of rambling, cycling and camping; the benefits to be derived from breast feeding and attendance at infant welfare clinics—

all these and many other health lessons may now be brought to the attention of the public by display on the hoardings. Local authorities are not slow to appreciate the advantage of this centralized poster production, as evidenced by the fact that in the first six months of this financial year, the Central Council has disposed of some twenty-three thousand posters and bills.

Apart from posters, the main medium of printed propaganda is the leaflet. Most of the Central Council's leaflets fall into several attractive series such as "Health Hints", "Hints from the Health Department" and "Shelter Bulletins". These cover a wide field of health education, ranging from brief outlines of diseases such as diphtheria, measles, whooping cough, infantile paralysis, tuberculosis and influenza, to the importance of bodily and sartorial cleanliness, sleep and the adequate feeding of baby, toddler and expectant mother. In addition, several pamphlets are available; while those leaflets and pamphlets dealing with the biological approach to sex education and the problems of venereal diseases (taken over from the British Social Hygiene Council) are, after suitable revision, being re-published in similar format. The scope of this type of publicity may be estimated by the fact that in six months some 885,000 leaflets and pamphlets have been distributed by the Central Council. Not content with this range, the Council is actively engaged on the preparation of new pamphlets dealing with the health of school-children (from the points of view both of the teacher and of the parent), with the problems of adolescence (for youth leaders), with the health of factory workers, and with biology as a medium of health education in the school; and of new leaflets concerning the health of the worker, the care of the feet, advice to dyspeptics, and other topics. In addition, an illustrated health booklet for children will soon be available.

A central health education agency could scarcely regard its work as satisfactory in the absence of a periodical, and the Central Council is in the fortunate position of having two. *Better Health*, a small popular monthly, achieves a circulation of 50–60,000, and, when paper limitations are removed after the War, should reach many times this figure. In addition to a popular magazine for the general public there has, however, been for many years a real need for a journal of a more specialist nature, to cater for those many people actively working in the field of health education. This need should be met by the publication, in January of 1943, of the first number of a new quarterly, *Health Education*. Articles by specialists will help to give educationists more information on medical matters, and medical people more on matters of education.

The first number will contain a message from the Minister of Health. Dr. Allen Daley (chief medical officer of the London County Council) will contribute an article describing the beginnings of health education in Great Britain, while Prof. J. M. Mackintosh will give his views of the primary aims in health education, and Dr. Charles Hill (chairman of the Central Council) will consider radio as a medium of health education. Mr. W. B. Little will discuss health education from the point of view of the school-teacher, and Dr. J. L. Picton from that of the general practitioner, while the problems of sex education will be considered by Mr. Cyril Bibby (education officer of the Central Council). This new journal should prove of the greatest value to medical practitioners, teachers, youth leaders, social workers, medical and educational administrators and indeed to all seriously interested in the matter of health education.

No educational body to-day can afford to neglect the medium of the film, and the Central Council has not been backward in this respect. It now has available for the use of local authorities some fifty films, covering the most varied aspects of health education. Droplet infection, nutrition, the care of the skin and of the feet, the conquering of fear, the historical development of the public health services, the biological approach to the study of sex and reproduction, the venereal diseases—all these are dealt with in the Council's films, in manners suitable for the most diverse audiences, from school-children and the general public to educationists and medical practitioners. Not content with this range of subjects the Council has at present in production new films on the head louse, venereal diseases, infant welfare clinics, and a film fantasy for children, showing the importance of cleanliness, exercise, fresh air, and good food.

During the last six months the Council's films have been shown at some four hundred special meetings. In addition, more than three hundred health films have been dispatched to a hundred borrowers. To meet this demand for visual health education the Central Council employs seven film operators, and possesses ten film and six film-strip projectors.

The radio is also a medium of the utmost importance, and it has not been neglected. In collaboration with the Central Council for School Broadcasting, the chairman of the Central Council for Health Education has given many health talks to school-children; and millions must hear him as the "Radio Doctor" in the B.B.C. programmes.

Important as all these methods of health education undoubtedly are, perhaps most potent of all is the spoken word of a lecturer to his audience. With the helpful co-operation of local authorities and the various national voluntary organizations, the Central Council arranges large numbers of meetings for many different types of audience, and more often than not the meetings are illustrated by films. During the six months from April 1 of this year more than 75,000 people have been reached in this way.

This number is but a small part of the total population of Great Britain, but many audiences are highly selected, consisting of influential persons, who will pass on the knowledge obtained to, or will be influenced in their dealings with, many others. This is particularly true of the meetings for school-teachers, who have such a great influence over children and young people. Thus it is reasonable to expect that the 762 teachers who have during these six months attended lectures at eleven different centres in the country will, as the years go by, affect favourably tens of thousands of the future citizens of the country. These teachers' refresher courses have dealt with the biological approach to problems of sex and of health generally, and have been fairly thorough courses of up to twelve sessions. The Central Council has built up a comprehensive display library of biology and hygiene books, and teachers have been very grateful for the opportunity of examining it at the meetings.

Similar significance beyond the mere figures of attendance applies to the 1,566 youth leaders and welfare supervisors who have in the same period attended courses dealing with the problems of adolescence; and to the 1,111 parents who have taken part in meetings dealing with the sex and health education of children.

An important feature of the work of the Central Council is the talks on sex and general health problems given directly to school-children and young people. No fewer than 1,466 of the former and 4,596 of the latter have attended courses of lectures given in this half-year in sixty different parts of the country, and all the signs are that the figures for the next half-year will be even greater.

During the period under consideration, approximately three thousand civil defence workers and seven thousand troops have attended meetings organized by the Central Council for Health Education, while factory meetings have reached some thirty-nine thousand workers.

Work of this variety and of this extent is possible only by the collaboration of skilled personnel and influential national organizations. Under its president the Archbishop of Canterbury, the Central Council meets as a widely representative body. Of Government departments, the Ministry of Health, the Board of Education, the Ministries of Food, Labour and Information, the Welsh Board of Health and the Scottish Education Department all have either representatives or observers on the Council or its Committees. In addition, there are representatives from the County Councils Association, the London County Council, the Association of Municipal Corporations, the Non-County Boroughs Association, the Metropolitan Boroughs Standing Joint Committee, and the Urban and Rural District Councils Associations.

The collaboration of the professions most concerned with health education is assured by representation from the Society of Medical Officers of Health, the British Medical Association, the Royal College of Nursing, the Dental Board of the United Kingdom, the British Dental Association, the Association of Directors and Secretaries for Education, the Association of Education Committees, and the National Union of Teachers. The field of health insurance is covered by representatives of the National Association of Insurance Committees, the Association of Welsh Insurance Committees and the London Insurance Committee, while collaboration with other health organizations is achieved by representation from the Conference of Affiliated Societies. In addition, the Council's Educational Advisory Committee has the benefit of the knowledge and experience of representatives from the British Medical Association, the Association of Women Science Teachers and the Science Masters' Association, and of many distinguished educationists (see also NATURE of November 7, p. 529).

Thus for the first time Great Britain has a really large and representative organization with skilled personnel devoted entirely to the enormously important work of health education; and the country should benefit greatly from it.

NEWTON TERCENTENARY

ROYAL SOCIETY CELEBRATIONS

THE anniversary meeting of the Royal Society, which is held on Saint Andrew's Day, November 30, was this year devoted, for the most part, to commemorating the tercentenary of the birth of Isaac Newton. The proceedings, which took place in the lecture theatre of the Royal Institution, were opened by Sir Henry Dale, president of the Royal Society, and the main part of his address is printed below.

We are within a few weeks of the three hundredth anniversary of the birth of Isaac Newton. Wherever the progress of our Western science and philosophy has become effective, men will remember what that event was to mean for the world. Newton, at the age of forty-three, when he had determined to abandon all further concern with natural philosophy, was induced at length, by Halley's friendly insistence, to give written form and system to the mathematical discoveries with which his amazing mind had been occupied over a period of some twenty years. The result was one of the greatest intellectual achievements in the history of mankind—the "Principia", providing for more than two centuries a framework for the mechanical interpretation of the universe and a basis for the building of physical science, and therewith of the material structure of our modern civilization.

We in Britain regard Isaac Newton as still, beyond challenge, the greatest of our men of science. Nor should the claim be limited to this island or to the British Commonwealth of Nations; for it was not until nearly half a century after Newton's death that former British colonists in North America began their development of an independent nation; and Newton is theirs as well as ours.

But, while we may proudly claim him as the countryman of all who share the birthright of the English tongue, the discoveries of science have belonged, and must belong again, to the whole world, and Newton's achievement is a part of the common heritage of all peoples. It cannot be doubted that, if it had fallen in normal times, this tercentenary would have been marked by the greatest of international gatherings, in which men of science and philosophers from all the world would have assembled to do honour to Newton's memory. It would have been natural then to expect leadership, in such an enterprise, from the only two institutions which were intimately concerned with Newton's career as a man of science—Trinity College, in Cambridge, and this our Royal Society of London. Our two foundations did, indeed, confer as to the wisdom of attempting by joint action, even in this year of war, to arrange such a restricted and domestic celebration as the present conditions would allow. We agreed, however, to put aside such planning for the present, carrying it forward in our hopes to the time when a world at peace may be able to join in international commemoration of an event which has meant so much for all mankind. May the time be not too far distant.

In the hamlet of Woolsthorpe, near Colsterworth on the Great North Road, some six miles south of Grantham, there is still a modest manor farm-house, with a small orchard in front of it. Here the Newtons lived, simple yeoman farmers, and here, two months after his father had died, Isaac Newton was born, a puny, premature infant, on Christmas day 1642, twenty years before the Royal Society was incorporated by the grant of its first Charter. The house stands but little altered since that day. The room in which Newton was born has a simple marble tablet on the wall, inscribed with Pope's well-known couplet. But this house had importance in Newton's later life and in his work, and not only as his birthplace. It was here that he returned from his schooling at Grantham, at the age of sixteen, to take charge of the farm for his mother; and here, to the incalculable gain of science and the world, he showed such incompetence as a farmer that he was sent back to school, and thence to Cambridge. It was here, again, that he returned in the autumn of 1665, when the plague drove him from Cambridge; and here, during the following eighteen months of quiet exile in the country, his early ripening genius grasped already the essential principles of his major theoretical discoveries. You can still see the upper chamber which he then used as a study; and in the little orchard there is an old, recumbent apple tree, which, they will tell you, is descended by direct grafting from that which Newton saw. The land which Newton's family farmed is rapidly being laid waste, alas, by quarrying for ironstone; and soon there will be little left unspoiled save the orchard and garden around the house.

It has seemed to us that, in this year of commemoration, something should be done to preserve for posterity a house and garden which carry such momentous memories, and which have meant so much for science. We have accordingly formed a small committee, in which Sir John Russell and Sir James Jeans have joined with the officers of the Royal Society; and we are in negotiation with the lord of the manor as to the possibility of acquiring this now tiny but historic property, so that it may be put for as long as possible beyond the risk of damage or decay.

Then I think that it is our special duty at this anniversary meeting to remember that, while Newton's great discoveries belong to the world, they came to publication through the Royal Society, and that Newton occupied its presidential chair for the last twenty-four years of his long life. Though his "Opticks" was not published until after he had become president, his original work for science was practically finished by the time of his election, and he had for some years been Master of the Mint. There can be no doubt, however, that the wide fame of his achievements, and the respect and admiration in which he was everywhere held, did much, at a critical period in its history, to establish the prestige of this Society in the eyes of the world. Let us then remember to-day that Isaac Newton, the greatest man of science of our race, was also the greatest of the Royal Society's presidents.

Sir Henry Dale also referred in appreciative terms to the attitude of the present owner of the Newton house and garden at Woolsthorpe, Major Christopher Turnor, who had expressed his willingness to dispose of the property for less than its value, for preservation as a Newton memorial. Sir Henry added that he had just learned that the Pilgrim Trustees would defray the cost of purchase. A photograph of the house was reproduced in NATURE of March 26, 1927 (Supp. p. 34), on the occasion of the two hundredth anniversary of Newton's death.

Sir Henry Dale's address was followed by lectures by Prof. E. N. da C. Andrade on "Newton and the Science of his Age", Lord Rayleigh on "Newton as an Experimenter" and Sir James Jeans on "Newton and the Science of Today". The manuscript of the first edition of the "Principia", the reflecting telescope and a solar sundial made by Newton, and other Newtoniana were exhibited in the library of the Royal Institution, together with demonstrations arranged by Lord Rayleigh to supplement those which accompanied his lecture.

OBITUARIES

Prof. J. N. Collie, F.R.S.

BY the death on November 1 of John Norman Collie, chemistry has lost one of her most outstanding personalities. To me, who knew him well from January 1889 until September 1939 when he left London to live in Skye, Collie was a true guide, philosopher and friend, and to-day it is my privilege to write of him as one of his last remaining friends for fifty-three years.

Collie was born on September 10, 1859, and was the son of the late John Collie. He studied chemistry under Prof. Letts at Bristol and afterwards was associated with Letts in two original investigations, the first on dimethylthetine ethyl ester and the second on tribenzylphosphine and tetrabenzylphosphonium salts.

In September 1888 Collie was appointed by Prof. W. Ramsay demonstrator in the Chemical Laboratories in University College, London, and I first met him when I entered the College as a young student in January 1889. Those of us who learned qualitative analysis under Collie found in him a born teacher, gifted with a salutary sarcasm which was tempered with a real understanding of the difficulties presented by a hitherto unknown field of study and provoked by strange results unrecorded in any text-book.

In 1896 Collie left University College on his appointment to the chair of chemistry in the College of the Pharmaceutical Society in Bloomsbury Square, London. In 1902 Collie returned to University College as professor of organic chemistry under Sir William Ramsay, the director of the Chemical Laboratories.

In the years following this appointment, Collie built up a great school of organic chemistry, and many men of high distinction to-day received their inspiration from him. Amongst these may be mentioned Prof. S. Smiles, Prof. T. P. Hilditch, Prof. A. W. Stewart and Dr. Irvine Masson. Just as on a ship the master is called the "Old Man", so it was in the organic laboratory, for Collie was invariably referred to as the "Old Man", a title of which he was very proud, for he knew all that in it lay—unbounded respect, admiration and affection.

Since my contacts with Collie in those years were mainly outside organic chemistry, it is more fitting that another should pay tribute to him as one of the great organic chemists of his time. Prof. Smiles writes: "I hesitate to compare Collie and Perkin, they were so different and yet supreme in their own line in their day. If I must compare them, I would attempt an analogy, a poor one as all such must be. Collie I would regard as the landscape gardener, whilst Perkin was the energetic producer of really fine crops of new varieties. Collie took a very broad view of the subject, the relations of various parts of it to one another, and of the whole to other branches of chemistry. He was no specialist, anything which savoured of narrowness was repugnant to his nature, but he was a true philosopher. It was this that made his lectures and his teaching so interesting, for there always seemed to be something intriguing beyond the horizon of what he was saying. Collie always seemed to publish reluctantly, but anything he did publish was nearly always of a fundamental character; for example, dimethylpyrone and the related compounds which led to his really comprehensive generalization on the polyketides. Collie was the first to suggest a labile formula for benzene, which was familiarly known in the laboratory as the 'Collywobble'. Moreover, his investigation of naturally occurring compounds, necessarily in small quantities, led him to devise his semi-micro method of organic analysis long before the days of Pregl."

In 1913, when Ramsay retired, Collie was appointed director of the Chemical Laboratories at University College, a position he held until his retirement as emeritus professor in 1928.

Now Collie was endowed with a remarkable versatility. In my days as a young student, he gave me what he called the education of a gentleman. At a series of dinners in his rooms in Camden Grove, he discoursed at length on the beauty of early printing and incunabula, the glories of Chinese lacquer, the grace of Japanese carving and the knowledge and appreciation of vintage clarets, each subject being illustrated by valuable examples.

Collie was also a true æsthete, for beauty wherever he found it made a strong appeal to him. During his investigations with Dr. Patterson on the effect of high potential electric discharges on gases at low temperatures, his great friend the late Sir Herbert Jackson said to him, "Collie, I truly believe that you are far more interested in the colours of the discharge than in the striking phenomena you are recording."

As is well known, Collie was an expert rock climber, but he was also a great mountaineer. He climbed many of the Alps, and in 1901, together with Mummery and Hastings, he attempted the ascent of Nanga Parbat in the Himalaya. In 1902, together with Stutfield, he climbed and explored among the Canadian Rockies, where he discovered the Columbia Group. The first expedition was described in "Climbing in the Himalaya", published in 1902, and the second in "Climbs and Exploration in the Canadian Rockies", published in 1903 under the joint names of Collie and Stutfield. Collie was in turn president of the Scottish Mountaineering Club, the Alpine Club and the Royal Geographical Society.

In 1903 Collie invited me to join a party who proposed to climb in the Lofoten Islands. This party included those other great men of the mountains, James Collier, William Cecil Slingsby and Herman Woolley. Under their tuition I learned the elements of the art, and in the following year Collie invited me to join him at Sligachan in the Isle of Skye. There it was my privilege to meet and later to climb with John McKenzie, the guide and ghillie of the hotel. John was a man of fine personality and under Collie's tuition he became a first-rate rock climber. It is true to say that John worshipped the ground on which Collie trod. Whether it were in walking, fishing or climbing, they were inseparable companions, and to those who knew them both it is singularly fitting that Collie was laid to rest alongside John's grave on the shores of Loch Harport, surrounded by the Mountains of the Mist they loved so well.

E. C. C. Baly.

Capt. G. T. McCaw, C.M.G., O.B.E.

Capt. George Tyrrell McCaw, who died on October 17, was the editor of the *Empire Survey Review* and one of the foremost and best known authorities on geodesy in the British Empire.

McCaw was born in Lurgan, Co. Armagh, Northern Ireland, in 1870, and, after a distinguished career at Trinity College, Dublin, graduated in arts and engineering in 1893. From 1893 until 1903 he was employed in the Irish Land Valuation Department, but, in 1903, he accepted an offer to join the Geodetic Survey of Rhodesia under the direction of the late Sir David Gill, at that time H.M. Astronomer at the Cape. This work lasted until 1906, after which he was engaged on the survey of the 30th meridian in Uganda, on the measurement of a base line in Sweden, and then in charge of the Trigonometrical Survey of Fiji, his published report on this survey being a model of what such reports should be.

McCaw returned from Fiji in 1917 and very soon afterwards joined the survey and mapping organization of the British Army G.H.Q. in France, where he acted as geodetic adviser connected with the coordination of the triangulation over the whole front. After the War he became technical assistant at the Geographical Section of the General Staff, War Office, and remained there until he retired in 1936. During this period he also acted as joint secretary of the Colonial Survey and Geophysical Committee and of the Air Survey Committee, his work in the former capacity bringing him into touch with surveyors and geodesists from all over the Empire. On several occasions he attended, as one of the British delegates, meetings of the International Union of Geodesy and Geophysics, and he often spoke at meetings of the Royal Geographical Society when technical matters relating to geodesy or survey were under discussion. He was a voluminous writer on geodetic subjects, and in 1931 he became the first editor of the *Empire Survey Review*, a semi-official journal which was founded under the patronage of the Secretary of State for the Colonies, mainly for the dissemination of technical information among the different Colonial survey departments. The high standard with which he launched this *Review* was maintained, in spite of difficulties caused by the War, until the time of his death. He himself, particularly during the War years, wrote a considerable part of each issue, and most of his contributions contained much matter that was original.

In 1924 McCaw was created O.B.E. (Civil Division) and in 1936, in view of his long connexion, both directly and through the Colonial Survey Committee, with survey matters in the Colonies, and the part that he had played in their development, he was made C.M.G.

Considerable as were his intellectual attainments, McCaw will chiefly be remembered by a very large circle of friends all over the world for his great personal charm, which endeared him to all with whom he came in contact. His advice, constantly sought by young and old, by junior and senior, was at the disposal of anyone who cared to ask for it, and, for that reason, most members of the various Colonial survey departments, when at home on leave, were glad to take the opportunity of calling at his office to discuss with him their own difficulties and problems. He was a most entertaining companion and a loyal and generous friend who was utterly incapable of a mean action.

J. Clendinning.

NEWS AND VIEWS

Joint Council of Professional Scientists

A JOINT COUNCIL of Professional Scientists, representing more than ten thousand qualified men of science, has been set up under the chairmanship of Sir Robert Pickard by the Institutes of Chemistry and Physics in association with representatives of professional botanists, geologists, mathematicians and zoologists. The Council has been established to voice the collective opinion of qualified scientists on matters of public interest, to provide a liaison between professional organizations of scientific men for co-ordinated action in matters of common interest, and in particular to concern itself with: (1) the utilization of men of science to the best advantage in the service of the community; (2) the education, training, supply and employment of scientific workers; (3) the better understanding of the place of men of science in the community; (4) the maintenance of adequate qualifications and ethical standards among professional men of science; (5) the supply of information and advice to public and other bodies on matters affecting men of science.

The members of the Council are as follows: *Institute of Chemistry*: Dr. J. J. Fox, Prof. Alexander Findlay, Dr. G. Roche Lynch, Sir Robert Pickard, Dr. H. A. Tempany, Mr. R. B. Pilcher; *Institute of Physics*: Sir Lawrence Bragg, Prof. J. A. Crowther, Mr. E. R. Davies, Dr. B. A. Keen, Dr. H. Lowery, Dr. H. R. Lang; *Representing Botanists*: Prof. W. Brown; *Representing Zoologists*: Prof. D. Keilin; *Representing Mathematicians*: Prof. S. Chapman; *Representing Geologists*: Prof. H. H. Read. The Joint Council has been established for the period of the national emergency, but it may form the nucleus of some more permanent organization to facilitate the close collaboration between professional men and women practising in all branches of science. Communications to the Council should be addressed to Dr. H. R. Lang, Honorary Secretary, Joint Council of Professional Scientists, c/o The Institute of Physics, at its temporary address, The University, Reading, Berks.

Industrial Reconstruction in Great Britain

A STATEMENT on "A National Policy for Industry" has been issued by a group of 120 industrialists in Great Britain as a contribution to the discussions on reconstruction (*The Times*, November 11). The statement, while urging that, as a producer, industry is by far the largest contributor to the material welfare of the nation, recognizes that industry has a three-fold public responsibility: to the public which consumes its products; to the public which it employs; and to the public which provides the capital by which it operates and develops. The underlying conviction of the whole document is that the spirit which should animate industry is service to the community as a whole, and emphasis is laid on four principles: (1) that the primary duty of industry is to the consumer; (2) that industry should acknowledge by accepting a code of performance towards the workers the partnership of labour in industry; (3) that in any central or sectional organization of industry special steps should be taken to safeguard the interests of small producers; and (4) that whatever form the further organization of industry may take should be and should remain a matter for the determination of Parliament.

The first part of the statement makes a spirited defence of the private enterprise in Great Britain under which industry has shown the essential qualities of imagination, boldness and resource, and the signatories consider that it is a necessary condition of achieving the requisite efficiency that the system of private enterprise continue. It is held nevertheless that the general standard of management can be further improved and that every possible step must be taken to achieve that end. Moreover, industry must recognize its social obligations in contributing to the work of physical reconstruction which will be necessary after the War. In regard to the suggested code of obligations towards employees, the statement refers specifically to co-operation with the trade unions, the development of works councils, holidays with pay, reasonable hours of work, a scheme of family allowances for children, and to part-time compulsory education up to the age of eighteen.

To assure to the consumer the full benefit of technical progress reflected in higher quality or lower prices or both, while establishing greater security for all, the signatories suggest that relations between firms, between different industries and between industry as a whole and Government, should be more fully and comprehensively organized in some form of permanent association. They advocate the classification of industry into sections, each of which should establish a sectional association charged with the duties of co-ordinating the activities and securing the collaboration of all producers in its own section. Beyond this they contemplate a Central Council of Industry representative of the whole of industry in Great Britain. In regard to the specific powers to make regulations and enforce decisions and membership which should be given to the association and Council, the statement points out that this is a matter for the determination of Parliament. It is recognized that ample provision should be made for the protection of the public as consumer, as well as of the small producer, and the establishment of an industrial tribunal or commission is suggested to which appeal could be made.

Colonial Policy

IN the House of Commons on November 26, Sir Edward Grigg moved an amendment to the address in reply to the King's Speech, in which he welcomed the declaration that it is desired to raise the standards of life of peoples in the Colonies, but regretted the lack of mention of specific proposals, including the establishment of a Colonial Development Board. He urged that further arguments about charters and abstract principles are no use, and that machinery should be set up at once to investigate the problems presented by the various Colonies, in order to be able to arrive at an agreed policy on them in relation with other Powers. In the course of the debate, reference was made to the unfortunate effect which may be produced in the Colonies themselves by the frequent changes during recent years in the Colonial Secretaryship.

Mr. Harold Macmillan, Under-Secretary for the Colonies, who replied for the Government, explained that Mr. Oliver Stanley, who has just succeeded Lord Cranborne as Secretary of State, could not be expected to define his attitude immediately. Meanwhile Mr. Macmillan outlined the present position in general terms. As regards the West Indies, he said that £1,500,000 has been spent on schemes under the Welfare Act, and a similar sum provided for the banana industry. Rice production is being developed. In British Guiana a series of drainage schemes are starting which it is hoped will revolutionize rice growing. The most important thing, however, is to attack illiteracy. The growing political consciousness of the Colonial peoples must be developed on sound lines, but the diversity of conditions in the Colonies makes a standardized approach inapplicable. Continuous association of Colonial peoples with their own welfare and development, and co-operation of all concerned, from the highest to the humblest official, in this endeavour, are the methods to be used. Sir Edward Grigg's amendment was then withdrawn.

International Copyright

MR. G. WREN HOWARD and Mr. Stanley Unwin, both of whom are past presidents of the Publishers Association of Great Britain, have issued a statement raising the thorny issue of international copyright. They point out that the last International Copyright Convention, signed at Berne in 1908, afforded a very considerable degree of protection to the literary and artistic property belonging to the nationals of those countries which signed it. The position to-day, however, is that, of the major active members of the United Nations, the British Empire alone is adherent to the Berne Convention. While Germany, Italy and Japan signed it, the United States of America, the U.S.S.R., and the Chinese Republic did not do so. For practical purposes, almost complete protection is enjoyed by the literary property of United States citizens throughout the British Empire, but it is difficult, owing to the conditions imposed, for British subjects to obtain copyright for their property in the United States. Again, while a translation from the Russian into English is copyright in Great Britain and throughout the Empire, no copyright is afforded to any British literary material by the U.S.S.R.; in China, a considerable trade in material reproduced by photographic process has grown up. It is therefore urged that steps should be taken forthwith, as a part of the plans for reconstruction which are under discussion, to introduce a system of international copyright as soon as world conditions permit.

Exhibition of Newton's Books

AN exhibition of books connected with Newton is being held in the Wigan Central Library from November 23 until early in 1943, to celebrate the tercentenary of the birth of Sir Isaac Newton, at Woolsthorpe, Lincolnshire, on Christmas Day 1642. The exhibition was conceived and organized by the borough librarian, Mr. Arthur J. Hawkes. He has managed to bring together from the resources of the Wigan Library, supplemented by a few books on loan, a most interesting collection of early works on science. It includes copies of most of Newton's published scientific papers and books, together with about one hundred works of earlier and contemporary authors bearing on Newton's discoveries. The original issues of the *Philosophical Transactions of the Royal Society* in the possession of the Wigan Library are exhibited, together with the first editions of Newton's "Opticks" (1704), loaned by Messrs. Bernard Quaritch, Ltd., and the "De Revolutionibus Orbium Coelestium" by Copernicus (1543), loaned by the Earl of Crawford. Messrs. Sotheran, Ltd., have loaned the copy of Isaac Barrow's edition of Euclid which was used by Newton as a student at Trinity College and bears many annotations in Newton's handwriting. All the books exhibited carry lengthy notes attached to them explaining their interest and significance in connexion with Newton.

The exhibition was opened on November 23 by Mr. Leonard Stanley Newton, who is a descendant of the Woolsthorpe family. Wigan is to be congratulated on not letting pass, in war-time, the occasion to celebrate the three hundredth birthday of Newton by the exhibition of "so many, and valuable philosophical truths as were never yet discovered and put beyond dispute by the capacity and industry of any one man whatever".

Ministry of Health: Medical Advisory Committee

THE Parliamentary Secretary to the Ministry of Health stated in the House of Commons on November 28 that a Medical Advisory Committee has been set up to advise the Minister on the medical aspects of problems relating to the health of the people. The members of the Committee are:

The presidents of the Royal College of Physicians, the Royal College of Surgeons, and the Royal College of Obstetricians and Gynaecologists; the chairman of Council of the British Medical Association; Dr. G. C. Anderson; Dr. J. C. Arthur; Miss A. Bloomfield; Dr. J. A. Brown; Dr. E. Rock Carling; Dr. J. A. Charles; Prof. H. Cohen; Dr. W. Allen Daley; Lord Dawson of Penn; Dr. E. A. Gregg; Lord Horder; Sir Wilson Jameson (vice-chairman); Dr. W. S. Macdonald; Dr. A. A. Moncrieff; Prof. R. M. F. Picken; Prof. H. Platt; Dr. A. T. Rogers; Dr. D. O. Twining; Dr. O. Williams; and Miss A. L. Winner.

Imperial Institute of Entomology

SIR GUY MARSHALL retired recently from the post of Director of the Institute and has been succeeded by Dr. S. A. Neave. The work of the Institute is well known. It publishes the *Review of Applied Entomology* and the *Bulletin of Entomological Research*, identifies insects submitted by entomologists from all parts of the world, distributes collections of named insects, provides initial stocks of parasites of economic importance, and acts generally in an advisory capacity and as a clearing house for matters connected with applied entomology throughout the Empire. A vacancy on the staff has just been filled, but there will be two others within the reasonably near future, and suitable candidates for these posts are now being sought. Further information can be obtained from the Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1, and applications made by May 1.

Bicentenary of Nicolas Leblanc

AMONG the world's benefactors whose discoveries have been ill-requited by their fellows was the French surgeon and chemist, Nicolas Leblanc, who was born at Ivry-de-Pré in the Département of Cher on December 6, 1742. Though of poor middle-class parents, he was able to study medicine at the Collège de France and ultimately became surgeon to the unfortunate Louis-Philippe-Joseph, Duke of Orleans. In 1775 the Paris Academy of Sciences offered a prize of 2,400 livres for a practical process of producing soda from common salt. By 1787 Leblanc had solved the problem, and through the generosity of the Duke was enabled, with Dizé, to erect a factory at St. Denis, and in 1791 a patent was granted him. In

1793, however, the Duke fell beneath the guillotine, and the factory was confiscated. Though in later years the factory was restored to Leblanc, together with a small monetary recompense, it was all in vain. Leblanc struggled hard against his misfortunes, but at the age of sixty-three his mind gave way and on January 16, 1806, he committed suicide. His process, however, gradually came into use and in 1883 Dumas, speaking to the Paris Academy of Sciences, said that the annual consumption of carbonate of soda in Europe and America, produced by Leblanc's process, was then estimated at between 700,000,000 and 800,000,000 kgm. In spite of this, little was known of the discoverer. Four years after Dumas spoke, a bronze statue of Leblanc was erected in the forecourt of the Conservatoire des Arts et Métiers in Paris.

Simplified Electrically Heated Hotbeds

A REPORT. Ref. W/T7, by C. A. Cameron Brown and E. W. Golding, issued by the British Electrical and Allied Industries Research Association, describes experiments carried out to determine whether a simple method of heating hotbeds electrically can be applied successfully to the intensive production of early salad crops in small frames such as are used by non-professional growers. The method consists essentially in equipping a frame with a soil-heating cable or with a transformer-fed bare iron wire to give a loading of 2–5 watts per sq. ft. Heating is controlled, from a convenient point in the domestic premises from which supply is taken, to give certain regular 'doses' of heat in each 24-hour period. These doses vary from 40 to 45 watt-hours per sq. ft. per day, depending on the district. The two most convenient modes of procedure appear to be either with a loading suitable for all-night running or with a lower loading suitable for continuous running. The method is designed for operation on the domestic two-part tariff and to take advantage of the low running charges available. The experiments have shown that the method is a practical and economical way of producing lettuces of first-class quality from mid-March onwards, with little attention and at a total cost, including overhead charges, well below the current retail prices in shops. While early lettuce is the main crop, other crops can be raised, either simultaneously, such as carrots, or in succession, thus adding to the value obtainable from the hotbed installation.

Tuberculosis in the United States

ACCORDING to the *Journal of the American Medical Association* of September 26, the United States National Tuberculosis Association has reported that 44 persons per 100,000 of population died of tuberculosis in 1941, as compared with 46 in 1940. In 1941 the deaths from tuberculosis in the United States amounted to 59,173, and 105,714 fresh cases were reported. The highest tuberculosis death-rate occurred in Arizona (171 per 100,000). Other high rates per 100,000 reported were in the District of Columbia (82), Tennessee (79), Maryland (74), Kentucky (67) and New Mexico (65). The lowest death-rate reported was from Utah (11). Other States with a rate far below the national average were Wyoming (13), Iowa (15), Nebraska (15), Idaho (16), North Dakota (18), New Hampshire (21) and Kansas (22). New York State reported 6,208 deaths —a rate of 45·5.

New Zealand Earthquakes

DURING August 1942, ten strong earthquakes were registered by the seismographs at Wellington, Auckland, Christchurch, Arapuni, New Plymouth and Tuai in New Zealand (*Prov. Bull.* No. P.126, New Zealand Seismological Report; Dominion Observatory, Wellington, N.Z., 1942, August). The earthquake on August 1 was a local shock, namely, the Wairarapa Earthquake, and that on August 29 had an estimated depth of focus near 600 km. Altogether there were twenty-three local shocks felt in New Zealand during the month, of which by far the strongest was that on August 1 at about 12h. 34·1m. U.T. with epicentre near lat. 41·0° S., long. 175·8° E. This was felt from near Auckland to Dunedin and Queenstown, and in parts of Wairarapa had an intensity of rather more than 8 on the Rossi-Forel scale.

History of Science

IN Catalogue 70, Messrs. E. F. Goldsmith and Co., of 45 Old Bond Street, London, W.1, are offering for sale the library of Prof. A. Wolf, formerly professor of the history and philosophy of science at University College, London, and some new acquisitions, amounting in all to 834 items. The catalogue includes works on anthropology, astronomy, biography, biology, botany, chemistry, mathematics, optics, philosophy, psychology and statistics. Among the outstanding volumes are the first edition of "Astronomici Veteres" (1499), Tycho Brahe's "Epistolæ Astronomicæ" (1595), Simon Stevin's "Œuvres Mathématiques" (1634), Scheele's "Chemical Essays" and Volta's "Collezione dell' Opere" (1816). Modern writers are represented by numerous works of Einstein (including his "Brief Outline of the Development of the Theory of Relativity" from the special issue of NATURE on Relativity published on February 17, 1921), Freud, Galton, Karl Pearson and J. J. Thomson.

Announcements

MR. ORVILLE WRIGHT, of Dayton, Ohio, has been elected an honorary member of the Institution of Mechanical Engineers in recognition of his distinguished contributions to mechanical science. Through many years of patient and productive experiment Mr. Orville Wright, with his late brother Wilbur Wright, developed an aeroplane, with wing sections, motor, and controls, which made possible the flight of Orville Wright in 1903.

PROF. G. P. THOMSON, professor of physics in the Imperial College of Science and Technology, is to deliver the May Lecture for 1943 of the Institute of Metals. His subject will be "Electron Diffraction". It is of interest to recall that his father, the late Sir J. J. Thomson, delivered the Institute's May Lecture in 1915, speaking on "The Conduction of Electricity through Metals".

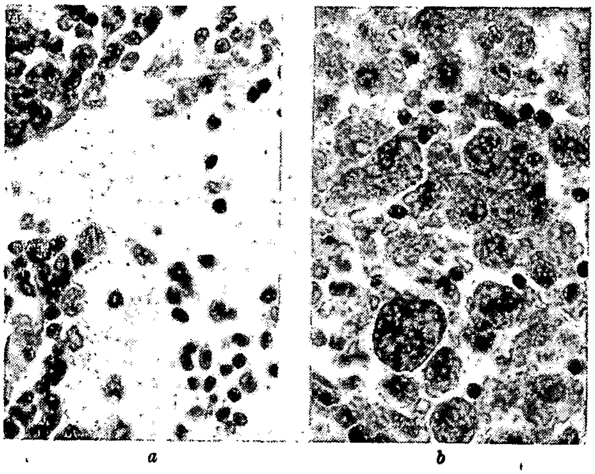
THE Faculty of Science of Marx House, London, organized a symposium on "Science and Technology in the Soviet Union" which was held during April 5 and 6 last (see NATURE, April 18, p. 426, and May 16, p. 545). Articles based on papers presented at these meetings by Prof. J. D. Bernal, Mr. H. P. Vowles, Dr. N. F. M. Henry, Mr. H. Rose, Dr. M. Ruhemann and Mr. J. L. Fyfe have now been brought together in a pamphlet, obtainable from the Organizing Secretary, Marx House, 1 Doughty Street, London, W.C.1, price 2*s*.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Formation of Hæmolymph Nodes in Rats Treated with 1 : 2 : 5 : 6-Dibenzanthracene

Previous investigators[1-4] have described the spontaneous occurrence of hæmolymph nodes in the rat. As a rule, two nodes situated in the vicinity of the kidneys were found to be the most conspicuous representatives of these structures. Their histological features were studied in detail by these workers ; but much uncertainty exists as to the origin and possible function of such nodes, and the same applies to those observed in other species of mammals. It is obvious that useful information might be obtained from experiments aiming at the conversion of ordinary lymph nodes into hæmolymph nodes, and our investigations in this field have led to a number of results, some of which appear to be conclusive. This note describes the effect produced in the lymph nodes of rats by treatment with the carcinogenic hydrocarbon 1 : 2 : 5 : 6-dibenzanthracene, the experiments being suggested by previous observations on rats treated with carcinogenic tar[5].



PART OF THE CENTRAL SINUS OF A CERVICAL LYMPH NODE. *a*, from a control rat; *b*, from a rat treated with 1 : 2 : 5 : 6-dibenzanthracene. Hæmatoxylin. × *c*. 340.

The hydrocarbon was administered in an aqueous colloidal solution, 27·8 mgm. (that is, 0·1 milli-mole) being dispersed in 100·0 c.c. of a solution of 5·6 per cent glucose and 0·5 per cent gelatine. 1·0 c.c. of this liquid was injected subcutaneously into a series of male pre-adult rats usually five times weekly for a period of about four weeks. This treatment was on the whole well tolerated. For comparison, other rats of similar weights were treated with a control solution (glucose-gelatine medium only), injected in a corresponding manner.

It was found that while the lymph nodes from the control rats were throughout of normal appearance, a number of the lymph nodes from the dibenzanthracene-treated rats showed a red or brownish-red discoloration on their surface, varying in extent and degree. A hæmolymphatic transformation of these nodes was thus indicated. The change occurred in all regions of the body ; its intensity—as regards the number of affected nodes and the amount of dis coloration in individual nodes—tended to increas with the duration of treatment, and appeared to b even greater some time after its termination. O microscopical examination, the following principa changes were observed in the structure of these node as compared with the nodes from control animals (1) a more or less distinct widening of the lymp spaces and corresponding diminution of the lymphati tissue ; (2) the presence in these lymph spaces o red blood corpuscles, frequently in considerabl numbers ; (3) an increase in the number of fre macrophages loaded with red blood corpuscles and greenish-brown pigment which, on applying th microchemical test for free iron, proved to be 'hæmo siderin'. From the latter findings it is evident tha the red cells present in the lymph spaces underg a process of destruction. An illustration of thes histological changes (stated under 2 and 3) is give by the two accompanying photomicrographs, take at high magnification. Part of the central sinus of cervical lymph node is shown in each, (*a*) referring t a control animal and (*b*) to a dibenzanthracene treated animal. It will be seen that in (*a*) the cel content of the sinus is confined to a number o lymphocytes and reticular cells, while in (*b*) the sinu contains in addition many red blood corpuscles a well as a number of free macrophages carrying bloo corpuscles and pigment. It is to be noted that th histological changes thus observed agree essentiall with the histological features of the renal hæmolymp nodes occurring already in control rats.

A detailed account of this work will be publishe elsewhere. Further investigations are in progres regarding the possible action of two other carcinogeni hydrocarbons (3 : 4-benzpyrene, methylcholanthrene and two related non-carcinogenic hydrocarbon (anthracene, phenanthrene), both groups of substance being employed in a similar manner to 1 : 2 : 5 : 6-dibenzanthracene. So far, it has been found tha hæmolymph nodes can be formed in rats treated with either of the two carcinogenic hydrocarbons, while no appreciable changes seem to occur in the lymph nodes of rats treated with either of the two non-carcinogenic hydrocarbons. These results, if confirmed by subsequent work, might indicate that the ability of a polycyclic hydrocarbon to produce hæmolymph nodes in the rat is in some way connected with its ability to produce cancer.

A. Lasnitzki.
D. L. Woodhouse.
Departments of Physiology and Pathology,
University of Birmingham. Nov. 12.

[1] Vincent, S., and Harrison, H. S., *J. Anat. and Physiol.*, 31, 176 (1897).
[2] Drummond, W. B., *J. Anat. and Physiol.*, 34, 198 (1900).
[3] Lewis, Th., *Internat. Monatsschr. Anat. und Physiol.*, 20, 1 (1903).
[4] Macmillan, R. E., *Anat. Rec.*, 39, 155 (1928).
[5] Lasnitzki, A., *J. Hygiene*, 38, 392 (1938).

Partial Purification of Cell Growth-Promoting Principles in Adult Tissue Extract

In a previous note from this Laboratory[1], it was reported that extracts of heterologous adult tissues possess the ability to stimulate *in vitro* the growth of various cells including human epithelium, and the use of adult tissue extracts in wound treatment was suggested. We report below the results of experiments carried out to purify the growth-promoting principles present in adult tissue.

Minced heart muscle of sheep or fowl was extracted with five parts of physiological saline solution and the extract precipitated with four volumes of 96 per cent alcohol. The precipitate was centrifuged and then dried over calcium chloride *in vacuo*. The dry product represents about 5 per cent in weight of the original material. It is slightly soluble in Ringer, better in Tyrode, and more readily in 0·01 *N* ammonium hydroxide. The growth of fibroblast cultures in a medium to which the solution of the alcohol precipitate in Tyrode is added is stimulated to the same degree as the growth of cultures treated with the original heart muscle extract. Repeated extraction of the dried alcohol precipitate with either acetone, ether or petroleum ether led to improvement of the stimulating power. Dialysis of solutions of the alcohol precipitate against Ringer did not affect their activity.

An ammonia solution of the alcohol precipitate was neutralized and precipitated by half-saturation with ammonium sulphate. The sediment was dissolved in dilute ammonia, carefully dialysed, and the solution evaporated *in vacuo* to dryness. The product thus obtained was almost entirely soluble in Tyrode and displayed good growth-promoting properties.

These experiments are only a first step. Nevertheless, their publication seems desirable, as during the course of this work alcohol precipitates possessing great cell-promoting power have been obtained. These preparations may represent a particularly appropriate material for experiments in wound healing. It combines with high potency the following practical merits: its preparation does not require sterile precautions except at the final stage; its storage is convenient and its stability is unlimited.

H. WERNER.
L. DOLJANSKI.

Department of Experimental Pathology
(Cancer Laboratories),
The Hebrew University,
Jerusalem.

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[1] NATURE, 150, 23 (1942).

Preservation of Plant Material

PRESERVATION of botanical material for teaching purposes is frequently necessary and is commonly achieved by keeping the material in alcohol. With whole plants, or bulky organs, for example many succulent fruits, large quantities of alcohol are required.

Satisfactory preservation may be obtained with many types of material by using a solution of sulphur dioxide, and this method has much to recommend it on the scores of convenience and economy. The use of sulphur dioxide as a preservative of fruits and fruit products for domestic and industrial use is well known. For domestic use "Campden Tablets", consisting of sodium or potassium metabisulphite, may be employed, each tablet as purchased containing the equivalent of 4 grains of sulphur dioxide, so that when dissolved in water (½ pint or 10 oz.) a solution containing approximately 0·1 per cent sulphur dioxide is obtained. This solution preserves most succulent fruits required for morphological studies satisfactorily. It has also proved adequate as a preservative of material required for anatomical work by elementary classes. Any slight hardening effect of the solution is not a disadvantage when herbaceous material is employed, and sections of the preserved material stain normally with common stains such as aniline chloride, iodine and phloroglucin. Anthocyanin pigments present are 'bleached' by the solution, but the blackening to which some plants, for example broad beans, are prone is prevented.

Directions for the use of the "Campden Tablets" include instructions to cork the bottle tightly, and to seal with wax. In fact, tight corking is generally sufficient, but frequent opening of the container in order to remove material is not permissible, as this allows oxidation of the sulphur dioxide and subsequent growth of mould. This is not a disadvantage when preservation of material for use on a subsequent single occasion is required, and even this trouble might be obviated by the addition of a tablet of preservative whenever the bottle has to be opened. Occasionally with fruits containing little free acid slight fermentation occurs[1] but fruits, flowers, stems and leaf material in freshly made solution, and in tightly corked containers, have all kept satisfactorily here.

In field use the method is convenient as the tablets are easily carried, and bottles of ½ pint (10 oz.) capacity or some multiple of this are obtainable in almost every locality and need only to be filled with water and tablets added at the rate of one to each ½ pint of water.

Clearly the adoption of this method of preservation results in the saving of an appreciable amount of alcohol, and at present this alone may well outweigh slight disadvantages that the method possesses.

L. G. G. WARNE.

Botanical Department,
The University,
Manchester, 13.
Nov. 5.

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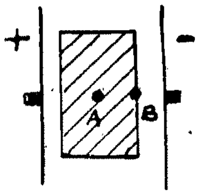
[1] Crang, A., "Preserving Fruits with 'Campden' Fruit Preserving Tablets". Ann. Report Agric. and Hort. Research Station, Long Ashton (1941).

Validity of the Clausius-Mosotti Formula

IN a paper published in 1940[1] I threw doubt on the validity of what is now called the Clausius-Mosotti formula and put forward another which, if correct, would considerably affect present values of the dipole moments of many substances.



In that paper I stressed the confusion between macroscopic and microscopic treatments of the problem. The difficulty may, perhaps, be seen more clearly from the following treatment of the usual case of a plane slab of polarizable material placed in the uniform field of a charged condenser as shown in the figure.

Consider the alternative cases, (1) the molecules are uniformly polarized; (2) the molecules are not uniformly polarized.

(1) If the molecules are supposed all uniformly polarized (and this can be proved only on the macroscopic view), there is no difference between the polarizing field at A and that at the boundary B. There is therefore no need to calculate the force E at A and say that, if the polarizability is α, then the moment of a molecule at A is αE. The moment at A is the

same as at B, and as B is on the boundary, this moment contributes to Poisson's Layer of surface density σ. If there are n molecules per cm.^{3} we have at once

$$\sigma = \text{electric moment per unit volume} = n\alpha E.$$

To relate this result to what is actually measured, namely, the drop in potential when the slab is introduced, we imagine a channel cut through the dielectric so that a unit positive charge may be taken from one plate to the other through it. If E_A is the intensity before the dielectric is inserted, the force in the channel is $E_A - 4\pi\sigma$, and experiment shows that this must be assumed to be E_A/K, since the potential drops to $1/K$ of its vacuum value, where K is the dielectric constant. Thus :

$$E = E_A - 4\pi\sigma = E_A/K = \sigma/n\alpha, \text{ whence } K = 1 + 4\pi n\alpha.$$

(2) If the molecules are supposed not uniformly polarized (and this must be the case on a microscopic view, since the polarizing force at A must differ from that at B owing to the different arrangement of surrounding molecules), then Poisson's volume distribution of charge must be taken into account as well as the surface layers in order to calculate the force at the centre of a spherical cavity. This is never done, and it could not be done for lack of information as to how the polarization varies from point to point. The treatment which Clausius gave is therefore not valid.

The conclusion seems to be that only a macroscopic treatment can be applied and that the formula should be

$$K = 1 + 4\pi n\sigma.$$

Thus for the molar polarization P we should have

$$P = \frac{K-1}{3} \cdot \frac{M}{\rho}$$

instead of Clausius-Mosotti

$$P = \frac{K-1}{K+2} \cdot \frac{M}{\rho}$$

(M is molecular weight, ρ is density).

G. BURNISTON BROWN.

University College of London,
at University College,
Bangor.
Nov. 8.

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[1] Brown, G. B., *Proc. Phys. Soc.*, 52, 577 (1940).

Shape of Subjective Space

THE apparent alteration in the size and shape and spatial relation of objects when right-eye and left-eye viewings are interchanged (or in other way the binocular parallax is reversed) may prove to some degree dependent on retinal structure, as suggested by Mr. Cox[1], but considerable alterations of like character are certainly accounted for by peculiar geometrical conditions, in conjunction with extreme quickness of the eyes and mind to interpret these as normally as possible.

More than ten years ago, I directed general attention to the astonishing effect of viewing the Hyades or Orion's Belt, or similar bright star group, through a common inverting binocular, when the stars are behind a familiar object like the bare twigs and branches of a tree, or the figure of a man, a little way off. To most observers with normal sight the stars appear in the air half-way to the tree, which in some cases may mean only a yard away through the binoculars. That provides or points out the general illustrative kind of case for such phenomena, even for the naked eyes, though the effects are rather feebly noticeable at long distances when telescopes are not used.

Briefly, explanations of the half-way appearance may be arranged like this: The distance d of the tree is assessed at once, in the ordinary view, by convergence (so far as the distance is short) and by the angular subtense which the tree shows as a chosen familiar object. After the reversal of parallax there is no natural convergence at all to use (only eye-straining divergence), but most observers still assess d well enough by the angular subtense. The ordinary relative parallax of the tree and heavens is like $\frac{1}{d} - \frac{1}{\infty}$. After reversal it is similarly like $\frac{1}{x} - \frac{1}{d}$, where x is the apparent distance of the heavens, a distance now less than d because of the reversal. Of course $\frac{1}{x} - \frac{1}{d} = \frac{1}{d} - \frac{1}{\infty}$, so $x = d/2$, and that the eyes and mind instantly recognize, after their lifelong experience of similar parallax problems. Only to the extent the object is not familiar, or not single and distinct but confused, may the observer not promptly recognize d, and then it is that the heavens are found reluctant to leave their usual remoteness. The telescopes of magnification m make x as small as $d/2m$; and they also aid by their ordinary telescopic flattening of the tree. The interchange of the far and near parts of the tree is curious but not very important. When the sun (or moon) is in view with the tree, the linear diameter of the sun appears as small as $d/230$ feet, which is sometimes as little as two or three inches. Intrusive twigs make a transparency effect.

It is evident that the subjective spatial change in this example is remarkable. The whole universe ha in effect been turned inside out at the dictate of the tree and its scale-fixing distance d. The outermost parts towards infinity have been brought in to a spherical surface of only $d/2m$ ft. radius around the observer, and parts nearest the observer have been dispersed towards infinity. Accordingly, to some observers in clear air over a featureless plain, dozens of men ranged in line from as near as th tree, outwardly to the horizon, appear as dwarfs nea at hand tapering outwards to become giants in th distance. Perhaps because the dwarfs are mor crowded, numerous and uninteresting, normality usually seems allotted to them, and magnification is declared the chief impression. Possibly causes o similar kind might be found involved in some of the magnification effects which have come under Mr. Cox's notice.

The mind's instant, unhesitating use of the eye and former experiences, or memory, as instrument in these subjective phenomena is noteworthy. The geometry and the eyes cannot prove the whole o the interest. In that connexion, regard should certainly be had to Sir Richard Paget's communication in NATURE of July 22, 1939, p. 153.

S. L. WALKDEN.

58 Raleigh Road,
London, N.8. Nov. 16.

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[1] NATURE, 150, 349 (1942).

RESEARCH ITEMS

Schooling of Mackerel

ARTHUR SCHLAIFER has made some interesting experiments ("The Schooling Behavior of Mackerel: A Preliminary Experimental Analysis". *Zoologica.* Scientific Contributions of the New York Zoological Society, 27, Part 2, No. 14; 1942). These were carried out at the Woods Hole Station of the U.S. Fish and Wildlife Service. The fishes used were 8-in. specimens of the chub mackerel, *Pneumatophorus grex* (Mitchell), caught in the waters off Woods Hole and afterwards kept in large tanks in the laboratory. It was found that two individuals suffice to form a school, swimming always in line with each other. If one mackerel is kept isolated and another is put in with it, the two immediately school and any others added join them. Schooling is seen still better in larger groups. Blinding, darkness and visual contact experiments indicate that the schooling reaction of the mackerel is visually integrated. Mackerel display no schooling reaction to others of the same species, dead or alive, which move or are moved in a manner not completely normal. Apparently there is no response to body colour. Isolation for three weeks does not eliminate or reduce the schooling proclivity. Good photographs are given of mackerel in fairly strong artificial light, in total darkness and in light in the deep red end of the spectrum.

Biology of a Carnivorous Snail

WILLIAM MARCUS INGRAM gives some interesting notes on *Euglandina rosea*, a well-known species common on the sea islands of Georgia and around the Keys of Florida ("Food, Eggs and Young of the Carnivorous Snail *Euglandina rosea* (Férussac)". *Zoologica.* Scientific Contributions of the New York Zoological Society, 27, Part 2, No. 15; 1942). A specimen was kept in a terrarium and laid eggs there. Experiments in feeding resulted in its eating the molluscs *Mesomphix inornatus* and *Anguispira alternata*, leaving untouched another species of Mesomphix, *M. cupreus*, and young and adults of *Triodopsis albolabrus*. It is evident that there is definite selection here. The method of feeding is described, the snail devouring the whole of the living prey from inside the shell. When completely inert it reacted directly to the food selected, and although ten inches away it was moving towards it within three minutes. All the molluscs eaten were first turned over on their apices. Twenty-two eggs, laid on the upper surface of the humus in the terrarium, exposed to the light, were about 3 mm. in length with hard calcareous shells. The approximate incubation period was 60-68 days, when the young broke through the shell by means of the radula.

Germ Cell Inclusions

THE investigations into the cytoplasmic inclusions in the germ cells of the mouse by Dr. R. A. R. Gresson have been continued in two further publications. One deals with the inclusions found during the maturation, fertilization and first cleavage division of the ovum (*Quart. J. Micro. Sci.*, 82, Pt. 4; 1942) and the other with those found during spermatogenesis (*Proc. Roy. Soc. Edin.*, B, 61, Pt. 2; 1942). The Golgi elements appear to be fairly evenly distributed throughout the period from maturation to the formation of the first two blastomeres. The mitochondria are most numerous in the central region during maturation divisions, a few being eliminated with the polar body. During the stage of the pronuclei they concentrate in the neighbourhood of these structures and they congregate around the first cleavage spindle in such a manner that they are distributed approximately equally to the two blastomeres, where they gather into small clumps and are then scattered singly throughout the cytoplasm. In the spermatogonia and spermatocytes the Golgi elements are situated at one pole of the nucleus; during division they remain near the equatorial region of the nucleus and either as two clumps or dispersed they are distributed to the daughter cells. In the young spermatids they are applied to the anterior pole of the nucleus but move away, leaving a vacuole, later filled by the acrosome, then bud off a small portion which moves to the posterior pole and this is later included in the middle piece of the sperm. The spherical mitochondria are most numerous in the neighbourhood of the nucleus in spermatogonia and spermatocytes, and in the transformation of the spermatid into the spermatozoon most of them come to lie around the axial filament. The sperm enters the ovum at the anaphase of the second maturation division.

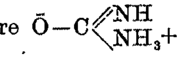
Parasites of Horses

A USEFUL account of the nematode parasites of the horse belonging to the family Strongylidæ as of Baird 1858 is furnished by Dr. W. A. Rosa and Dr. E. J. Galofre (*Inst. Parasit. Enfer. Parasit. Univ., Buenos Aires*, 1, Fasc., 6; 1940). The 19 species treated are divided among four genera: Strongylus 3 spp., Triodontophorus 2 spp., Trichonema 13 spp., and Gyalocephalus 1 sp. The introductory portion consists of a good general account of the anatomy and classification of the family. The remainder of the paper consists of a series of plates, one for each species, of drawings to scale of the diagnostic and comparable parts of both sexes of the strongyles. The plates are accompanied by fully annotated explanations and measurements, so that it should render the identification of any of the species comparatively easy.

Genetics of the Sorghums

IN a series of notes originating from the Millets Breeding Station, Coimbatore, G. N. Ayyangar and various co-workers describe the mode of inheritance of a number of characters in the Sorghums (*Current Science*, pp. 491, 492, 528 and 533; 1941). One of the most interesting is a dominant mutation for purple anther base (A_b), detected in the heterozygous condition in *Sorghum dochna* and later found to be due to a single gene closely associated with one of the two B genes for brown pericarp colour. The independent genes C_1 and C_2 behave as simple dominants and deepen the light green of normal lines, thus accounting for the dark green (C_1C_2), green (C_1c_2 or c_1C_2) and light green (c_1c_2) noted in the blocks of plants forming the World Collection of Millets at Coimbatore. The curious habit of 'goose-necking' (bearing heads on recurved stems) shown by some of the Sorghums is brought into line with genetical observations. The recessive gene wy results in a wavy peduncle to the inflorescence: this condition in a plant having a naturally short peduncle causes the ear to twist and escape out of the side of the last leaf (the 'boot') and so become bent into a 'goose-neck'. The relatively rare long type of hairs found on the glumes of *S. dochna* var. *burmaniium*, *S. Roxburghii*, *S. caffronum*, *S. coriaceum* and *S. cernuum* are described as due to an independent dominant gene *Gf* which lengthens the hairs produced by the gene *Gh* for the normal hairy condition. *GfGh* results in long hairs, *gfGh* the normal hairy condition and *Gfgh* or *gfgh* 'glabrous'.

Structure of Urea and Thiourea

Previously reported values for the dipole moment of urea (8·6) and thiourea (7·6) are unexpectedly high in comparison with those of related compounds, and these constants have been redetermined in dioxane as solvent at 25° by W. D. Kumler and G. M. Fohlen (*J. Amer. Chem. Soc.*, 64, 1944; 1942), who find the values 4·56 and 4·89, respectively, which fall in line with those of similar compounds. The molecules were not associated in these solvents. The results throw some light on the old controversy as to whether urea and thiourea are amphions. This was at first taken to imply the structure  $\bar{\mathrm{O}}-\mathrm{C}\begin{matrix}\nearrow\mathrm{NH}\\ \searrow\mathrm{NH}_3+\end{matrix}$ but later $\bar{\mathrm{O}}-\mathrm{C}\begin{matrix}\nearrow\mathrm{NH}_2+\\ \searrow\mathrm{NH}_2\end{matrix}$, involving a separation of charge but no proton transfer, and thus a resonance hybrid. The moderate values of the dipole moments show that such structures do not contribute predominantly to the state of the molecule. The short C to N distance has been supposed to indicate an amphion structure, but this amounts only to about 20 per cent of double bond character. The fact that the ratio of the solubility of urea in alcohol to its solubility in water is much higher than for an amino-acid with an amphion structure also makes such an ion structure in alcohol improbable. It seems as if everything can be accounted for by about 20–30 per cent of amphion structure, the essential structure of urea and thiourea being that of simple amides except for a somewhat larger contribution of the forms with a separation of charge.

Structure of Galactic Clusters

George Alter has a paper on the structure of galactic clusters (*Mon. Not. Roy. Astro. Soc.*, 102, 4) deducing a number of important tentative conclusions. He starts by assuming that the structure of a galactic cluster depends on the development of the cluster, which is of two kinds: (*a*) the dynamical evolution of the whole unit; (*b*) the spectral evolution of the individual members. Trumpler proposed a hypothetical evolution of clusters, which was based on a detailed classification according to the presence of yellow or red giant stars and the earliest star type within the cluster, and Alter simplifies this by a regrouping into four classes. It is suggested that clusters develop from the giant cool class through the giant hot and main hot to the main cool class, but with a certain indeterminacy near the central classes, where short transitions may occur. From a number of tables it is shown that the relations between these four classes and various structural properties of galactic clusters support the suggested scheme of classification. It is believed that the clusters develop along a life-line similar to that of the Russell diagram, and during this evolution the clusters are subject to the influence of the galactic field. The initial volume of 10–100 cubic parsecs increases until disintegration leads to the loss of stars merging with the surrounding star field. The lowest recognized average spatial star density within a cluster is about five times that of the star density in the vicinity of the sun, and the highest is about 250 times as much. The true values are actually higher, and this is explained by the star numbers used for determination being restricted by the magnitude limit of the photograph. The largest observed volume is about 1,000 cubic parsecs.

Voltage Surges Caused by Contactor Coils

A paper on this subject by J. R. Taylor and C. E. Randall, read before the Institution of Electrical Engineers, discusses the phenomena associated with the switching of contactor coils, particularly with reference to the effects of 'switching peak' voltages on insulation and switch contacts. The effect of circuit layout on the switching peaks and the arcing of contacts is described, together with methods of reducing the severity of these effects. Owing to a series of insulation breakdowns, it was decided to make an investigation of the switching-off voltages of a D.C. contactor coil. Early experiments were merely qualitative, but later, equipment was built for quantitative tests. Photographic records of the various phenomena were made in order to give a clear picture of the different conditions which are met. Peak voltages up to ten to fifty times the supply voltage occurred. Eventually it was decided to extend the research to A.C. contactor coils, and peak voltages up to five to six times the mains voltage peak were found to occur under favourable conditions. It is obvious from the tests that clearances which are satisfactory for electric lamps on 230 volts are totally inadequate for coil circuits even on 100 volts, and that on higher voltages it is essential to have large clearances and creepage distances. Instances are known of sparks jumping distances of as much as ½ in. along the surface of slate on control panels connected to 530-volt tramway supplies.

Grid-Controlled Mercury-Arc Mutators

R. Feinberg, in a paper entitled "Static Conversion of Direct Current to Alternating Current with Grid-Controlled Mercury-Arc Mutators" (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 22; October 1942), deals with the theory of the push-pull mutator invertor, which is a D.C. arrangement with grid-controlled mercury-arc mutators operating alternately and causing an alternating current to flow in the load circuit. In the case of resistance load, practically any shape of alternating voltage wave-form between rectangular form and triangular form can be produced. The shape of the alternating voltage wave-form depends upon the capacitance of the invertor capacitor, a relatively small capacitance giving the alternating voltage a rectangular form and a large value making it triangular. The ripple factor of the direct current is governed by the smoothing effect of the inductance in the D.C. circuit, a small inductance causing the direct current to flow intermittently. The degree of regulation of alternating voltage at any change of load is determined by the capacitance of the invertor capacitor. A large capacitance may produce such a large voltage regulation that the curve of power output plotted against load describes a V form, the power output being increased when the load is reduced. The invertor stops working when overloaded. Calculations are given for approximate circuit conditions, and the results of experiment have been found to agree satisfactorily with the theory.

MEDAL AWARDS OF THE ROYAL SOCIETY*

Copley Medal

THE Copley Medal has been awarded to Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford.

Sir Robert Robinson is recognized in all countries as one of the world's leaders in organic chemistry, and is one of the greatest and most versatile of investigators in that department of science. His researches, with a long and notable succession of pupils and collaborators, have covered a remarkably wide range of problems in this field, and his approach to these has been distinguished by brilliance in conception and a genius for the selection of methods leading to the desired solutions. Robinson's investigations have been particularly concerned with the chemistry of natural substances, products of the life processes of plants and animals. His work has thus been a potent factor in the tendency of organic chemistry to return, in recent years, to an objective nearer to that of its origin, and to make contacts of growing intimacy and value with biochemistry, a more recent development in response to the stimulus of functional biology.

This occasion does not permit any attempt at a complete or detailed survey of all the different fields which Robinson's work has illuminated and opened to further exploration. Special mention must be made, however, of his long series of fundamental investigations on the constitution and relationships of the plant alkaloids. His theory of the biogenesis of plant products seems rather to have inspired than to have resulted from his own early and elegant synthesis of tropinone; and it has revealed an unforeseen and coherent relationship between the constitutions of different groups of alkaloids, and given a great stimulus to work on their synthesis. The work published from Robinson's laboratory has been fundamental to understanding of the isoquinoline and the indole series of alkaloids, of morphine and its allies, and of the structural formulæ of strychnine and brucine, which formed the subject of his Bakerian Lecture.

Of at least equal scientific rank is the work which Robinson carried out and inspired over many years on the anthocyanin and, more recently, on the anthoxanthin pigments of plants, culminating in the synthesis of the actual colouring matters of flowers, and forming as a whole one of the most brilliant achievements in the whole range of modern organic chemistry.

Robinson's mastery of synthetic resources, and his penetrating instinct for clues to organic constitution, have been further demonstrated in a more recent approach to the synthesis of the steroids, in the production of series of compounds of interest for chemotherapy, and in notable studies of individual natural substances of a range of other types. He is, moreover, a philosopher as well as a master of experimental possibilities; and his theory of organic reactions, in the modern, electronic terms of valency bonds, has had a great influence on the development of fundamental conceptions in organic chemistry.

The Copley Medal is the highest recognition of scientific achievement in the Royal Society's gift, with no limitations of subject or nation; and the Society may well find cause for satisfaction in the knowledge that the award of its premier medal, this year for achievement in organic chemistry, after an interval of many years, finds among its own fellows a recipient of such unquestioned pre-eminence as Sir Robert Robinson.

Rumford Medal

The Rumford Medal has been awarded to Dr. G. M. B. Dobson, reader in meteorology in the University of Oxford.

The Rumford Medal awarded by the Royal Society was established for the recognition of important discoveries made in Europe, especially on heat or on light. These conditions appear to be met with a special fitness in the award of the Medal this year to Dr. G. M. B. Dobson, for his meteorological researches and discoveries. For Dobson's work has, in recent years, greatly extended knowledge of the linkage between the behaviour of ozone and cyclonic disturbances, in that complicated heat engine which is the earth's atmosphere; while light may be said to have provided the basis of measurement for Dobson's spectrographic studies of the distribution of ozone, in time and in height above the earth's surface.

Light had also a major concern in earlier researches on meteors in which Dobson collaborated with Prof. F. A. Lindemann (Lord Cherwell); in these, the study of the heights between which meteors become luminescent enabled them to draw conclusions as to the density, and from these as to the temperature of the atmosphere at great heights from the earth's surface. But it is especially on Dr. Dobson's own studies of the ozone of the atmosphere, continued over many years, and producing results of outstanding importance for meteorology, that the award is based.

Royal Medals

A Royal Medal has been awarded to Prof. W. N. Haworth, professor of chemistry and director of the Chemistry Department in the University of Birmingham.

Haworth's great claim to distinction arises from the revolutionary change which has been produced by his own investigations, and by those of his immediate pupils, in the whole aspect of an important section of organic chemistry, dealing with the structure and the relationships of the carbohydrates. The ring structure of the simple sugars, first proposed by Tollens and supported by the work and the authority of Emil Fischer, had been generally regarded by chemists as firmly established. Detecting insecurities in the arguments which led to this formulation, Haworth developed the methylation technique, first used by Purdie and Irvine, and applied it systematically to the monosaccharides. He was thus able to show, by unequivocal methods of organic chemistry, that the accepted ring structure of these sugars was incorrect, and that, in their normal and reactive forms, they were derivatives of pyran and of furan respectively.

Later, Haworth further developed his methods in application to sugars and carbohydrates of increasing complexity. By his work, and that of others who have followed his lead, the detailed structures of many disaccharides and of some trisaccharides have been established. Progress has further been made in his attack on the structural complexities of the polysaccharides, and a simple chemical method has been evolved for determining their minimal molecular weights. Prof. Haworth's work, in the field which he has thus made his own, has received the high international recognition of a Nobel Prize, and will assuredly take rank as a major achievement of permanent significance in chemical history.

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* Remarks made by Sir Henry Dale, Pres.R.S., in presenting the medals for 1942.

A Royal Medal has been awarded to Dr. W. W. C. Topley, formerly professor of bacteriology and immunology, University of London, now secretary to the Agricultural Research Council.

Dr. Topley is one of the most distinguished of the British bacteriologists of recent years. The most important of Topley's contributions to bacteriology and experimental medicine has been the experimental study of epidemics, which he initiated and of which the methods have been largely his own creation. Much had been learned by the statistical analysis of observational data, dealing with the origin, spread and development of natural epidemics, under conditions largely out of control. Topley conceived the idea of applying such methods to the investigation of epidemics started artificially in populations of healthy mice, kept in the laboratory under conditions which could be exactly controlled and deliberately varied. Thus the factors conducive to the rise, culmination and decline of an epidemic, to its revival or its final subsidence, could be experimentally determined. In a long series of such studies, the important results of which were reviewed in his Croonian Lecture for 1941 on "The Biology of Epidemics", Topley had the statistical co-operation of Prof. Major Greenwood, in both planning and interpretation.

On this firm basis of knowledge concerning the incidence and mortality of a naturally transmitted infection in untreated stock, the efficiency of prophylactic measures could be put to a controlled test. Under Topley's guidance and inspiration, accordingly, substantial progress has been made by his chemical colleagues towards the isolation from various species of pathogenic bacteria of highly purified and stable antigens, and the practical trial of some of these was interrupted by the outbreak of war.

Dr. Topley's researches have had a great and lasting influence on the study of bacteriology, immunology and epidemiology in relation to human medicine. His recent change of the focus of his interests may be expected to give an important stimulus to advance in many cognate fields of agricultural research.

Davy Medal

The Davy Medal has been awarded to Prof. C. N. Hinshelwood, Dr. Lee's professor of chemistry in the University of Oxford.

The award has been made for Prof. Hinshelwood's work on the kinetics of chemical change, characterized by its pioneering quality and by the varied new lines of research which it has opened up. An experimental investigator of great skill and achievement, Hinshelwood has also enlarged the theory of the subject by able mathematical analyses and descriptions based on the concepts of collisions and of activation energy.

Hinshelwood took a leading part in the early study of homogeneous gaseous reactions. As the result of the examination of a number of bimolecular examples, he was able to show, with reason, that these are confined to molecules containing few atoms, and that the actual rate was given by the product of the total collision rate and the probability of a molecule possessing the experimental energy of activation. Unimolecular reactions were found to occur with polyatomic molecules and to show more complex features. In association with Prof. F. A. Lindemann (Lord Cherwell), Hinshelwood put forward the mechanism, now accepted, whereby a reaction fundamentally dependent on collisions may nevertheless have unimolecular kinetics. This theory he was able to verify by showing that the rates of such reactions diminish at low pressures and that the kinetics then become bimolecular.

In the field of chain reactions Hinshelwood opened up new lines of advance by studying the therma reaction between hydrogen and oxygen. Thus he discovered, and offered clear explanations for, the curious phenomenon of 'explosion limits', confining explosive reaction, at any fixed temperature, sharply to a particular pressure region. Elaborate studies on the effects of nitrogen peroxide and other foreign gases on the hydrogen–oxygen reaction brought to light the very great kinetic complexities of an apparently simple type of chemical change. In this work Hinshelwood directed attention to the influence of the container surfaces on chain reactions, and also clarified the confusion of evidence concerning the effects on reaction rates of the intensive drying o gases. His discovered the inhibition of certain gaseous reactions by nitric oxide and interpreted the effec as due to the removal of radicals from, and the suppression of, 'chains'.

Hinshelwood has also carried out a large number of experiments on heterogeneous reactions and shown that their differences in kinetic behaviour can be explained by the application of the concepts of Langmuir.

Throughout all these researches, carried out with the utmost economy and directness, though with full experimental precautions, and interpreted in the mos lucid manner, Hinshelwood has never lost sight of the essential complexity of chemical reaction mechanisms. He has always been ready to modify his views in accordance with new experimental evidence, and to make the fullest use of the more recent developments of wave-mechanics and of statistical mechanics. Summarized by their author in two well-known treatises, Prof. Hinshelwood's distinguished researches furnish abundant ground for the award to him of the Davy Medal.

Darwin Medal

The Darwin Medal has been awarded to Prof D. M. S. Watson, Jodrell professor of zoology and comparative anatomy at University College in the University of London.

Prof. Watson is pre-eminent among palæontologists for his contributions to knowledge of the course of vertebrate evolution. His researches have been concerned mostly with the origin of the land vertebrates, with the fishes most nearly related to them, and with the main line of evolution leading to the mammals.

It will not be possible to survey here Watson's work in all its aspects, and mention must be restricted to some of the major lines of advance which it has opened. His Croonian Lecture, in 1925, summarized the conclusions which he had reached by that date as to the evolution of the Amphibia, demonstrating for the first time the relationship of the Stegocephalia to the Osteolepid fishes. In addition to tracing the descent of land vertebrates thus from Amphibia back to fishes, Watson followed the line of the evolution of the mammals, through early, primitive reptiles, the Cotylosaurs, to the mammal-like reptiles, in a large series of valuable papers. He related this work on the reptiles to that on the amphibians in a paper on the evolution of the shoulder girdle of the Tetrapoda

In this work on the fossil vertebrates, in its relation to the course of evolution, Watson has not confined his attention to morphological details, but, with an enterprise remarkable in a palæontologist though characteristic of his outlook, has considered where possible the functional significance of the structures preserved in the rocks; thus he has considered the mode of action of the shoulder girdle and deduced the nature of the musculature of a group of marine fossil reptiles.

Pursuing his study of mammalian origins, Watson was led to study the most primitive of living mammals, the oviparous Monotremes, and to discover that characters in which their skulls differ from those of other mammals can be regarded as extreme developments of features observed in the skulls of certain fossil, mammal-like reptiles.

Watson's work has continued in full vigour into recent years, and has brought two further contributions of major importance to the study of evolution in the vertebrates. One is concerned with the origin of the frogs from more primitive amphibian types, while the other shows that a group of fishes from the Old Red Sandstone constitutes a separate class of vertebrates, equal in rank to and ancestral to the remaining fishes.

Tracing, in this brilliant series of researches, the main stages of the descent of the mammals from their earliest fish-like ancestry, Prof. Watson has certainly performed "work of acknowledged distinction in the field in which Charles Darwin himself laboured".

Buchanan Medal

The Buchanan Medal has been awarded to Sir Wilson Jameson, formerly dean of the London School of Hygiene and Tropical Medicine and since 1940 the chief medical officer to the Ministry of Health and the Board of Education.

In both capacities Jameson has shown himself to be a man of stimulating influence and leadership, determined and persistent in his efforts to ensure that advances of medical knowledge in the laboratory, the clinic and the field shall receive prompt application n administrative practice.

Largely to Jameson's vigorous policy is due the hope that active immunization against diphtheria, which has banished the disease from many large communities of North America, will at length find systematic and effective application in Great Britain, where many of the discoveries were made which have rendered it safe and practicable. In the prompt official adoption of methods using modern technical resources to deal with the recent increase of tuberculosis under war conditions, and in the recognition of adequate and scientifically planned nutrition of the people as a central item of an effective health policy, Jameson's active and enlightened influence can again be discerned.

Of the grounds on which the founder of the Buchanan Medal desired the awards of it to be made, Sir Wilson Jameson's high claim to it is based on 'administrative and constructive work" of outstanding merit in the service of hygienic science.

Hughes Medal

The Hughes Medal has been awarded to Prof. Enrico Fermi, now of New York.

Prof. Fermi has made most notable contributions both to theoretical and experimental physics. In the early days of the modern quantum theory he was one of the first theoretical physicists to appreciate the generality of the considerations put forward by Pauli and known as the 'exclusion principle'. This led him to discuss the statistical theory of a perfect gas of particles in equilibrium, obeying this principle, with results which were obtained independently and almost simultaneously by Dirac by similar methods. These results of Fermi and Dirac are of the utmost importance in the modern theory of assemblies of similar particles, such as electrons, protons, and neutrons. Following this outstanding personal contribution, Fermi played a great part in building up at Rome a distinguished school of theoretical physics, where he himself made one of the earliest successful attempts to construct a theory of radioactive β-ray change. This theory shows the most profound insight into the theoretical nature of the quantum theory.

His interest in the atomic nucleus led Fermi naturally to his experimental studies in this field. Immediately after the discovery of the neutron, he realized that it provided a new possibility of attack on the nucleus and of stimulating nuclear change by neutron bombardment. This work opened up the fruitful modern field of study concerned with the transformations of nuclei of medium and great atomic number, and led directly to the most exciting transformations of all, the nuclear fission of uranium and thorium.

Prof. Fermi's work is characterized throughout by profound insight and great experimental skill. In the fields which he has made his own he is universally acclaimed a leader.

ANALYSIS AND TESTING OF COAL

THE testing of coals for their suitability in use, even after many years of effort, continues to give rise to investigation. This is due to the great economic importance of fuels, change in methods of utilization, and also to the fundamental complexity of the nature of coal. Unlike many raw materials, every coal contains several constituents, recognizably distinct, which vary in composition and character according to their origin and geological age. Moreover, they contain inorganic matter which varies widely in chemical composition and physical properties.

These complexities make the actual chemical composition of secondary importance, with the possible exception of the sulphur content. The so-called 'proximate analysis' is of prime importance as a guide to the usefulness of a coal. This involves the measurement of the quantity of combustible and of incombustible matter. Each is further subdivided —the combustible into 'fixed' carbon and volatile matter, the incombustible into 'ash' and 'moisture'. By means of these empirical tests, the observant and experienced analyst can reach useful conclusions as to the suitability or unsuitability of a coal for many purposes. Standardization of such a test is essential and more than forty years ago the American Chemical Society drew up a standard procedure. A few years later the United States Bureau of Mines made a start on this work, which has been continued in other industrial countries until a vast literature has been collected.

Dr. A. C. Fieldner, chief of Fuels and Explosives Services, U.S. Bureau of Mines, in his Melchett Lecture to the Institute of Fuel, delivered by talking film on October 13, traced the development of testing methods in the United States. It was early found that the kind and quantity of inorganic constituents greatly influenced the serviceability of a coal. Fieldner himself was closely associated with the necessary tests. As time went on, further specialized tests have been developed—a work in which British chemists have largely participated, particularly in association with the British Standards Institution. Only recently the Institution has issued a new edition of British standard methods for the sampling and analysis of coal. It reveals a noticeable increase in the elaboration of method, even in regard to the simple 'proximate analysis'. This is doubtless due to the fact that the simplicity is more apparent than real, and the complexity of coals provides many pitfalls.

The wisdom of over-elaborating the apparatus and method of the 'proximate analysis' is open to question. There is a place—the largest place—for a test in which a crucible is heated over a Bunsen burner. If a greater precision is required, it is possible that a more precise test than that now prescribed is preferable. Time has brought more and more specialized tests, designed to judge the suitability of a fuel for defined applications, for example producers, hand- or machine-fired, mechanical stokers, carbonization processes. War-time conditions have emphasized the need for these. In peace-time, coals tended to gravitate into appropriate channels, which war-time difficulties have choked or diverted. This has forced some industries to give thought to the more exact determination of their needs in order to secure that substitutes shall be really effective. All this has emphasized the importance of the subject of coal testing.

H. J. Hodsman.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, December 5

Society of Chemical Industry (Yorkshire Section) (in the Hotel Metropole, Leeds), at 2.30 p.m.—Dr. G. W. Scott Blair: "Some Rheological Problems in Industry".

Saturday, December 5—Sunday, December 6

Association of Scientific Workers (with the support of the British Association) (at Gas Industry House, 1 Grosvenor Place, London, S.W.1)—Conference on "Scientists of the United Nations and the War Effort".*

Saturday

At 2.30 p.m.—"Allied Scientists" (Chairman: Sir Richard Gregory, Bart., F.R.S.).

Sunday

At 11 a.m.—"Free National and Refugee Scientists" (Chairman: Prof. John Marrack).

At 2.30 p.m.—"British Scientists" (Chairman: Sir John Russell, F.R.S.).

Monday, December 7

Society of Chemical Industry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. W. D. Jones: "Powder Metallurgy".

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Dr. L. Dudley Stamp: "The Scott Report on Land Utilization in Rural Areas".

Tuesday, December 8

Chadwick Public Lecture (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Dr. W. Norwood East: "The Differentiation, Prevention and Treatment of Anti-Social Behaviour Disorders".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. J. C. Drummond: "The History of our More Important Foods", (iii) Dairy Produce.*

Illuminating Engineering Society (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Discussion on "Lighting and Post-War Reconstruction (Guidance, Specification and Legislation)", to be opened by Mr. A. G. Higgins.

Wednesday, December 9

Royal Society of Arts (at John Adam Street, Adelphi, London W.C.2), at 1.45 p.m.—Dr. George Yeh: "The Cultural Life of War time China".

Physical Society (in the Cavendish Laboratory, Cambridge), a 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: A lecture on Newto (in celebration of the Tercentenary of Newton's Birth).

Institute of Physics (in the Lecture Theatre of the Royal Institution, Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—T celebrate the Three-hundredth Anniversary of the birth of Sir Isaa Newton. Dr. H. Lowery: "Life of Newton"; Dr. H. F. Buckley "Some Historical Aspects of Newton's Published Works".

Thursday, December 10

Institute of Fuel (at the Connaught Rooms, Great Queen Stree Kingsway, London, W.C.2), at 2.30 p.m.—Mr. H. E. Partridge "Fuel Economy at Collieries".

Pharmaceutical Society (at Friends House, Euston Road London, N.W.1), at 2.30 p.m.—Dr. R. Melville: "Medicinal Indigenous Plants".

Friday, December 11

Royal Society of Arts (India and Burma Section) (at Joh Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Kahn Bahadu Sir Azizul Hugue: "Rural Self-Governing Bodies in India".

Physical Society (Colour Group) (at the Lighting Service Burea of the E.L.M.A., 2 Savoy Hill, Strand, London, W.C.2), at 2.30 p.m —Dr. John W. Strange: "Fluorescent Materials and their Colours" Mr. G. T. Winch: "The Photometry and Colorimetry of Fluorescen Lamps"; Mr. H. G. Jenkins: "Commercially Useful Fluorescen Substances"; Mr. F. W. Coppin: "The Use of Fluorescent Pigment in Colour Printing".

Royal Institution (at 21 Albemarle Street, London, W.1), a 5 p.m.—Mr. E. R. Davies: "The Photographic Analysis of Motion'

Saturday, December 12

British Mycological Society (at the Linnean Society, Burlingto House, Piccadilly, London, W.1), at 2 p.m.—Miss E. M. Blackwell "On Germinating the Oospores of *Photophthora cactorum*" (Presidential Address).

Free German Institute of Science and Learning (at 16 Buckland Crescent, Hampstead, London, N.W.3), at 5 p.m.—Prof. M Polanyi: "The Scientific Community".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Dairy Bacteriologist for the London Area—Th Acting Principal, The College, Wye, Ashford, Kent (December 8).

Lecturer in Biology—The Registrar, Technical College, Sunderland, Co. Durham (December 11).

Lecturer in Physical Chemistry—The Registrar, The Universit Bristol (December 12).

Instructor in Beekeeping—The Education Officer, County Hal Wakefield (December 14).

Lecturer in charge of Mining at the St. Helens Municipa Technical College—The Director of Education, Education Offic Cotham Street, St. Helens (December 14).

Head of the Department of Science and Technology, an Head of the Commerce Department, of the Southend-on-Sea Municipal College—The Chief Education Officer, Education Office, Warric Square, Southend-on-Sea (December 18).

Headmaster of the King Edward VI Grammar School—Mr. John Hales, Clerk to the Governors, The Close, Norwich (December 18).

Assistant Lecturer and Demonstrator in Botany—Th Secretary, West of Scotland Agricultural College, 6 Blythswood Squar Glasgow (December 28).

Regius Professor of Geology at Edinburgh University—Th Private Secretary, Scottish Office, Fielden House, 10 Great Colleg Street, London, S.W.1 (January 11).

Assistant Master with good qualifications in Mathematic and Engineering, and an Assistant Master (or Mistress) to tak Geography and General Science—The Principal, Technical Institute,, Gravesend.

Assistant (male or female) to the Public Analyst—The Secretary, Health Department, Grey Friars, Leicester.

Veterinary Investigation Officer—The Principal, Universit College of Wales, Aberystwyth.

Physics Instructor in a leading Technical College in Chile—Th British Council, 3 Hanover Street, London, W.1 (endorsed 'Chile').

Physics Master, and a Chemistry Master, in the Victoria Colleg Alexandria—The British Council, 3 Hanover Street, London, W. (endorsed 'Alexandria').

Research Assistant (male) with Zoological or Agricultura Qualifications to work on Pest Control—Wood Pigeon Investigation, Edward Grey Institute, 39 Museum Road, Oxford.

Assistant Analyst—The Medical Director, Evans Biologic Institute, Runcorn, Cheshire.

Laboratory Attendant—The Laboratory Superintendent, Department of Chemistry, Imperial College of Science and Technolog South Kensington, London, S.W.7.

NATURE

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RELATION OF CO-OPERATION TO MORALE

THE increasing stringency of the labour position and the ever more searching demands upon the man-power and woman-power of Great Britain are steadily driving home the lesson that the central problem in efficient production is that of securing effective co-operation. That problem is encountered in the munition factories, in the shipyards and in transport; it is the dominant factor in solving the important problem of absenteeism. The true secret of the high production-levels of 1940 lies less in the long hours worked than in the spirit of the workers. The whole nation had been lifted to a level which made for effective co-operation and high morale.

To maintain morale and co-operation at that high level throughout the course of a long war is no easy task, but it is the key to victory. Without it we are likely to relax, and jeopardize all the harvest that now promises to be reaped from the African campaigns and the months of planning, vigil and training that made their success possible. Primarily, that is a responsibility of management, as the Select Committee on National Expenditure has rightly insisted, that term being understood to include the production departments of the Government and not of the industrialist alone.

As Prof. Elton Mayo points out in his foreword to Prof. F. J. Roethlisberger's recent book "Management and Morale"*, we must first of all recognize that whereas material efficiency has been increasing for two hundred years, the human capacity for working together has in the same period continuously diminished. It is true that the desire for continuous and intimate association in work with others persists, but the very strength of this persistent desire retards rather than promotes effective co-operation. The relative isolation of small groups and their constant feeling of insecure tenure induce an attitude of suspicion or even hostility to other groups or, in industry, to management. This is the road by which we drift to what historians call stasis—the disintegration of a community into an infinity of mutually hostile sections. In war or in peace alike, chaos and downfall are the sure result.

Clearly we cannot leave collaboration in a society any longer to chance. Prof. Roethlisberger's volume, addressed primarily to business executives, is a study of what is involved in collaboration, and he indicates methods not in conflict with the democratic tradition which can be applied to the remedy of social and industrial disorders. He shows that collaboration is a field for serious study and research, and he should also stimulate much fruitful thought regarding the handling of certain problems of personnel in industry, perhaps more especially in regard to incentives and the very complex issues involved in absenteeism. In particular his book should lead to an attempt to aim our methods at the maintenance of co-operation and not merely at mechanical efficiency.

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*Management and Morale. By Prof. F. J. Roethlisberger. Pp. xxii+194. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1941.) 11*s*. 6*d*. net.

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Prof. Roethlisberger starts from the Western Electric Company's researches at the Hawthorne Plant, which although they have been described in such books as Elton Mayo's "Human Problems of an Industrial Civilisation", T. N. Whitehead's "The Industrial Worker" and "Statistical Studies in Industrial Research", are still far from being as widely known as they deserve. These researches demonstrated that the responses of workers to what was happening about them depended on the significance those events had for them. His book, in fact, is an essay on human situations in business; it examines the hypothesis developed in these researches, uses their method to explore the complex human relations in a business organization and suggests the conditions for effective collaboration.

Industry, it is urged, is a social as well as an economic phenomenon, and leadership should be based on understanding as a prerequisite. The social structure of any particular company determines the kind of collaboration, the kind of people who will stay in the company, and the kind of people who will reach the top—an observation which is highly pertinent in considering the proposals in regard to the post-war structure of industry and trade recently advanced by a group of a hundred and twenty industrialists in Great Britain. Many industrial problems clearly need re-definition in terms of social structure; it is a fallacy to assume that with an intelligent understanding of the conditions necessary for getting raw materials and the technical production and distribution of goods, we need give little attention to the problems involved in co-operative effort.

The War at least has taught us that we cannot safely assume that the human problems of effective and purposeful association in work can be left to take care of themselves. Fundamentally, indeed, it might well be argued that the problem of civilian morale in war-time is that of so integrating individual and group activities with the national needs and purpose, that there is the maximum satisfaction of individual and of group and national demands. Obviously that objective cannot permit the misunderstanding or friction which will arise if a particular economic activity is torn apart from its social fabric and treated as a thing in itself. Neither can management continue to subsume the problems of group collaboration under the technical problems of production and efficiency. The social, as well as the physical, structure of an industrial concern must be considered, and regard had to the effect of a technical change introduced by the management on the social as well as the physical location of the individuals and groups of which modern industry is built up. Above all, there must be explicit understanding by the management of the social structure of industry, and effective communication up and down the line as well as between the different groups within the industry.

The importance of communication cannot easily be overstressed. Prof. Roethlisberger's chapter on "Words and Men" deals a shrewd blow at the jargon in which inefficiency and muddle so often attempt to clothe themselves. If communication and collaboration between groups in industry are to be effective, it is as important, if not more important, for management at the top to understand and appreciate the behaviour of the people at the bottom level, as it is for the bottom group to understand the logical and economic objectives. On that truth rests the whole case, in the larger sphere of world affairs, for a statement of war aims, and Sir Stafford Cripps's recent speech to the International Youth Conference in London went far to show that this is at last being appreciated by the Government. The situations and sentiments of individuals and groups which make up an organization, a society or a nation must be understood by its leaders before they practise the art of persuasion or assurances to secure loyalty, confidence and co-operation.

The importance of personnel management was stressed in the latest report of the Chief Inspector of Factories. Accepting the fundamental conception of industry as a problem of personnel as well as an economic phenomenon, Prof. Roethlisberger shows that the first human problem in a business concern is to secure the co-operation of people in attaining its collective purpose. The problem has three major aspects: first, relating to the channels of communication within the organization through which employees can learn about their duties and obligations in relation to its purpose, and express their feelings and sentiments about their methods and conditions of work; secondly, maintaining a social balance within the organization so that employees by contributing their services are able to satisfy their desires and hence are willing to co-operate; and thirdly, effecting the individual adjustments required to assist particular employees with difficulties to become better oriented to their situations.

These human problems are not simple or easy to solve, but they must be faced in any efficient industrial organization; and until they are faced and solved generally, our war effort will lack something of its full power. That much is clear from the reports of the Select Committee on National Expenditure and of the Chief Inspector of Factories. What is equally important but by no means so fully appreciated is that if we neglect them we may well lose the peace The human problems are indeed the crux in planning for the future. No planning which fails to take account of them is likely to be effective. Whereas it is important to have the machinery of planning established and the broad lines of policy determined in readiness, it is equally important that the purposes and objectives of that planning should be made known so as to secure the measure of co-operation that will be indispensable to success.

It is the great merit of democracy that its methods and traditions promote the solution of this problem of maintaining under given conditions the type and kind of equilibrium which make for the maximum efficiency and collaboration. Much of the mischie of the past thirty years has come, as Prof. Ernest Barker shows in his prescient "Reflections on Government", from our disregard of the democratic process Prof. Roethlisberger's study tends to support the view that friction and failure in business enterprise is due to the absence or imperfect development o those methods of open discussion and voluntary agreement which characterize the democratic State.

There is no distinction between the problems of morale in an industrial organization and those in any other organization or society. There are the daily problems of maintaining internal equilibrium, that is, of maintaining the kind of social organization in which individuals and groups working together can obtain human satisfactions that will make them willing to contribute their services to the economic objective of co-operation. There are the daily problems of diagnosing possible sources of interference, liquidating human tensions and strains among individuals and groups, helping people to orient themselves to their work groups, and detecting blockages in the channels of communications. These indeed are the very problems which tend to be overlooked, at least outside of the Armed Forces, under the stress of war, and without leaders skilled in diagnosing human situations we cannot preserve the social values which are so essential in a co-operative system. Prof. Roethlisberger's book, with all its suggestiveness and practical hints, is by and large another exposition of the truth of the ancient proverb, "Where there is no wisdom the people perish". Nothing could more surely hasten the day of full victory than leadership which, from top to bottom, handled the human problems of production and organization—and reconstruction—with understanding, imaginative insight, and the same courage which marked the finest hours of the summer and autumn of 1940.

COSMOGONY AND RELIGION

The Beginning and End of the World

Riddell Memorial Lectures, Fourteenth Series, delivered before the University of Durham at King's College, Newcastle-upon-Tyne, in February 1942. By Prof. Edmund Taylor Whittaker. Pp. 64. (London: Oxford University Press, 1942.) 2*s*. 6*d*. net.

EVERY year the Riddell Trust arranges for a course of lectures on "the relation between religion and contemporary development of thought". The Lectures for 1942 deal particularly with the relation between cosmogony and religion, and it is a matter for congratulation that the trustees have found a lecturer who is well-versed in both science and theology.

The greater part of the book consists of an exposition of the findings of astronomy and physics as to the beginnings and endings of the universe. This is admirably done, and would suffice by itself to make the book one of outstanding merit. Yet most readers will be mainly interested to see what Prof. Whittaker has to say on its religious implications. He tells us that the purpose of his lectures is to maintain the doctrine "that God, the first cause and last end of all things, can, from created things, be known with certainty by the natural light of human reason". From the evidence of science that the world is of finite duration in time, he deduces an argument against pantheism —if God were Nature and Nature God, then it would be necessary for God to be born and perish, which is absurd.

Apart from this, there is no sustained effort to discover God "from created things", or through any form of science. Whittaker holds that the influence of science on religion must be psychological rather than logical—new developments in science can never alter the Christian faith, but only man's receptivity to that faith. Here he is, of course, thinking of the immutable cast-iron faith of the Roman Church, rather than of the plastic faith of the liberal Anglican. This latter has often changed its shape (in so far as it has any shape) through the impact of new scientific truth—as, for example, through the recognition that our earth is not the physical centre of the universe, but a fragment which has become detached from a grain of sand in that vast swirling sand-storm we call space. With this in his mind, can the enlightened churchman of to-day be expected to hold, with his pre-Copernican ancestors, that the revelation to Moses on the mountain, or the birth of the Holy Child, were events of cosmical importance? Or, with Whittaker, that the Incarnation gave to this small planet the value of the universe, and to a narrow span of time the value of eternity? We wish that Prof. Whittaker could have discussed such questions, but he debars himself from so doing at the outset.

The reflection that "mankind appears for a brief space of time, a short instant in the duration of the stellar system, and then disappears" brings him to the age-old question: "Can the grand sum total of existence be so utterly futile as that?" To this he replies that in the copepods, which exist in countless billions in the sea, the individual counts for nothing and the race is everything, but that when we come to man the race loses its importance and the individual life acquires the supreme value. "The goal of the whole process of evolution, the justification of creation, is the existence of human personality." But this, as Whittaker agrees, is a matter of "what it is reasonable to believe", and not of what science encourages us to believe. Species after species lived on earth for many millions of years before extermination befell it; there can be no scientific warrant for supposing that man, who has not yet survived his first million years, and seems already to be making a fair mess of things, is the final culmination of creation.

The plain fact seems to be that cosmogony has disappointingly little to say on religion. The two never make real contact, still less come to grips—how could they? "The things that are seen are temporal, but the things that are not seen are eternal." Cosmology may confirm the first half of the Apostle's dictum, but provides too narrow a platform for the discussion of the second half. Science can speak with philosophy, and philosophy with religion, but attempts to short-circuit philosophy have usually failed, and perhaps must always fail; the universe does not carry its secrets written on its sleeve.

J. H. JEANS.

BRADLEY'S DIALECTIC

Bradley's Dialectic

By Dr. Ralph Withington Church. Pp. 189. (London: George Allen and Unwin, Ltd., 1942.) 10*s*. 6*d*. net.

THERE is real satisfaction for a lifelong student of philosophy, when he finds the loyalties of his youth emerging from obloquy and arresting the attention of a generation whose temper of mind is inevitably alien to his own. It is thus at the present time with Bradley. As Hegel said, it is a tribute to the greatness of a philosopher that he compels his successors to refute him. During the half-century that has passed since Bradley dazzled the academic world into submission by "Appearance and Reality", a host of critics, mostly hostile and destructive—Moore, Cook Wilson, Russell, Broad, Alexander and Whitehead—have done their damnedest, until it had become almost a *cliché* with younger thinkers to dismiss Bradley as a back number in metaphysics. They were tired of monism and the absolute and of idealist epistemology in general. Yet Bradley is still a living force, and now even the youngest, disillusioned with the new gods, are beginning to be interested in discovering for themselves what it was he had to say. Indeed, the two greatest in the above-mentioned list, Alexander and Whitehead, frankly confessed their indebtedness to Bradley's teaching; and have thereby contributed not a little to stimulate this revival of interest. The book before us, like Prof. Blanshard's more elaborate work "The Nature of Thought", bears witness to its vigour in the United States.

Dr. Church, who has already written on Hume and Malebranche, here devotes himself to the task of expounding the principles of Bradley's metaphysics. With his views on ethics and religion—perhaps the most valuable and suggestive facets of his thought for the present-day reader—he is wholly unconcerned. He is a purist, out for the rigour of the game, and keeps his eyes steadily fixed on questions of logic and metaphysics. These, for Bradley as for Hegel, stand or fall together as a single inquiry. In logic the crucial issue is that of the meaning to be attached to the principles of identity and contradiction. Henry Sidgwick once remarked, apropos of Hegel, that he could never make out when a contradiction was just a contradiction or when, on the other hand, it veiled a sublime truth. With the abstract formulation of these principles, A is A and A is not not $-A$, cherished by contemporary logisticians, Bradley will tolerate no compromise. It leads to the apotheosis of tautology, and for him tautology is the very negation of thought. Contradictories, he holds, mean contraries, so that between them a way lies open for a process of mediation. To present the law of contradiction in the form that contradictorily opposed propositions cannot both be true is to offer a circular definition; for it assumes that we already know what contradictory opposition is.

What Bradley means by contradiction is admirably expounded by Dr. Church in his seventh chapter (one of the best in the book), entitled "Identity in Difference". He means the assertion of a bare conjunction of unrelated characteristics. "To unite without an internal ground of connection and distinction is to strive to bring together barely in the same point, and that is self-contradiction" (117). In other words, and here the logical doctrine appears in the foundation stone of Bradley's metaphysics, all identity is relational and implies qualitative difference. That is why, following Bradley's own lead (7,15), Dr. Church opens with a detailed analysis of his argument in the too-much neglected chapter (6) on "Relation and Quality" in Part I of "Appearance and Reality". To this argument he returns again and again, with perhaps excessive reiteration, throughout the book; for all Bradley's metaphysical doctrines, his monism, his absolutism, his theory of degrees of truth and reality, as well as the logic of contrariety, are based upon it. The point of the denials that relations are merely internal or merely external is clearly brought out, with special reference to Dr. Ewing's ten possible meanings in which the phrase "internal relations" can be understood. Free use is made not only of Bradley's *magnum opus*, but also of his important posthumous notes for an essay on "Relations".

That Dr. Church quotes Bradley's own words frequently is fortunate for the reader, for his own style in commentary and elucidation is by no means free from obscurity. In fact, we are constantly reminded how Bradley, like God in the well-known hymn, is "his own interpreter, and he will make it plain". One further ground of criticism is Dr. Church's use, in expounding the principle of identity in difference, of the phrase, "concrete universal". What is meant is, of course, a systematic whole of differents; but such an entity is not a universal at all, but an individual. The phrase, of course, is ever on the lips of Hegel and of Hegel's followers; but seldom has an important speculative truth been sponsored under such an ill-omened name.

In the penultimate chapter (7) Dr. Church discusses certain "basic difficulties" that stand in the way of a wholehearted acceptance of Bradley's metaphysic. For one thing, there is the denial of any merely numerical differences in quality, a denial that is in accord with the whole trend of Bradley's argument. It does not admit of demonstration, either *a priori* or by induction. But, the author points out, the assumption "is not made arbitrarily" but forced on Bradley by experience. Experience is a process of becoming, and qualities and relations that differed *solo numero* would be self-identical and unchanging, and "could not be moments in any process of becoming" (149). Moreover, there is the crowning obstacle that since the absolute can stand in no relations, "we are left at the close with no criterion of degrees of truth or reality" (157). Degree of coherence is an index to degrees of intellectual satisfaction. But can we assert the converse, that "the fuller the satisfaction, the higher the coherence"? Surely not so; and we are left, owing to our restricted knowledge of the absolute, without "an index of degrees of coherence" (159–160). It looks, therefore, as though Bradley's absolutist metaphysics rested, not only at the start but also at the close, on what can scarcely be otherwise described than an act of faith.

W. G. DE BURGH.

READINGS IN THE HISTORY OF BOTANY

A Short History of the Plant Sciences

By Prof. Howard S. Reed. (A New Series of Plant Science Books, Vol. 7.) Pp. x+320. (Waltham, Mass.: The Chronica Botanica Co.; London: William Dawson and Sons, Ltd., 1942.) 5 dollars.

AN author who does not write a book to order chooses his own subject matter and has a perfect right to do so. In making his choice he is guided by certain considerations of which his own particular interests are likely to be among the more important. For this reason we cannot complain of the content of Prof. Reed's book. On the other hand we have every reason to feel aggrieved at the title he has selected, for it must give the prospective reader a very wrong idea of what he will find between its covers. For what are we to think of a history of the plant sciences which deliberately excludes any account of the development of plant genetics and fossil botany, or of systematic botany after the eighteenth and plant geography and ecology after the nineteenth centuries, and in which the only aspect of physiology considered is metabolism ?

About a third of the book, comprising the first seven chapters, consists of a statement of botanical and horticultural knowledge at different periods of the world's history, beginning with an account of the plant lore of the early civilizations of Assyria, Egypt, China and America and then proceeding from what the author calls the nascent period (sixth century B.C. to second century A.D.) to the seventeenth and eighteenth centuries. After an intercalated chapter on gardens, later work on a number of botanical topics is summarized in the remaining eleven chapters. The extraordinary lack of balance in the treatment of the subject is again evident here, for of these eleven chapters no less than six are devoted to certain aspects of metabolism, while plant geography, morphology, cytology, mycology, pathology, are restricted to one each.

In writing a history of any science it should surely be the aim of the historian to trace the development of the science in its various branches and to show how the discoveries made and theories held at any time have led to further discoveries. With this in mind, how is it possible to write a history of the plant sciences without an adequate account of the work of Charles Darwin ? For this work had a profound influence on the development, not only of genetics, but also of morphology, physiology and systematic botany, and it is clear from his Introduction that the author is fully aware of this. Yet in Prof. Reed's book the only observation of Darwin's which is described in detail is that on vacuoles in the tentacles of Drosera, and the reason why this selection should have been made is quite unclear.

Indeed, the whole book takes only too often the form of a series of abstracts of selected pieces of work by various investigators of greater or less distinction, but it is not always at all obvious on what principle the selection has been made. Thus no work on photosynthesis during the last fifty years has had a greater influence on the development of our knowledge of this subject than that of F. F. Blackman, yet in the chapter on the fixation of carbon by plants no account is given of this work, and Blackman's name does not even occur in the list of references at the end of the chapter.

From what has been written above it must not be concluded that the book is without interest. On the contrary, the author has here brought together much valuable information which is certainly not readily accessible to the majority of botanical students. This is particularly the case as regards the knowledge of plants and horticultural and agricultural practice in early times, and for this reason the first few chapters make interesting reading. But the author has wider aims than the provision of such matter. One of his intentions is "to guide students during the formative period to a better understanding of past and present trends and to clarify the increasingly complex situation into which they will eventually be thrust". But one wonders what a student "in the formative period" and without a training in Egyptology makes of references to the fifth, twelfth, eighteenth, twentieth and twenty-sixth dynasties without any indication as to when these flourished; and when he is told that the original habitat of the potato is a matter of paramount importance for many reasons, he would surely like to know these reasons, but he is not told. Again, can he make sense of the statement "there is evidence that he knew more about the matter than we suspect" ? This is, perhaps, only careless writing, and probably the same judgment can be made on the author's statement that he has "sought to give vitality to outstanding men".

But what of the following pronouncements from the first chapter ? "The study of the broader aspects of the plant sciences ought to orient the student and to counteract, to some extent, the effects of the inevitable specialization which modern scientific curricula impose upon him. The flood of technical papers which continually surges over the tables and into the bays of the libraries dismays the student who wishes to evaluate the progress of science. To say nothing of the cultural, there is also practical value in having some background for judging things pertaining to a field of science, if one is to avoid grasshopper habits of thinking." And again, "One must get a long view if he can distinguish the real direction of man's progress in botany among all the devious, puerile ways in which he squandered his time and energy. And let it be remembered that we of this day may be, and probably are, beating about the bush or chasing rabbits as assiduously as our predecessors."

Were it not that British and American literature in general proves the contrary one might be tempted to agree with Prof. Reed's compatriot who, in a recent broadcast, said "The British and the Americans are alike in that they both believe, wrongly, that they speak the same language". W. STILES.

THE CONTENT OF MATHEMATICS

What is Mathematics?

An Elementary Approach to Ideas and Methods. By Richard Courant and Herbert Robbins. Pp. xix+521. (London, New York and Toronto: Oxford University Press, 1941.) 25s. net.

THIS is a thoroughly good book which deserves to run through many editions. It is not (as its title might suggest) a book on mathematical logic or philosophy: it deals not with the *nature* of mathematics but with its *content*. Its purpose is to show, not by general disquisitions but by concrete examples, drawn from almost every branch of pure mathematics, how mathematicians think and what they do.

I know only three good books with similar aims: Whitehead's "Introduction to Mathematics" in the Home University series, Rademacher and Toeplitz's "Von Zahlen und Figuren", and Dresden's "An Invitation to Mathematics"; and Dresden's is the only one of the three which really challenges comparison. The other two books, excellent as they are, are slighter and much less systematic, and Whitehead's is written more from the point of view of a logician. It is odd that the best two books of the kind should both be American, but the public for which they are designed is no doubt largest in America.

The writing of such a book, for "beginners and scholars, students and teachers, philosophers and engineers", is a formidable task which requires an unusual combination of qualifications. The authors must be professional mathematicians, since no one else can have the reserves of knowledge and the mastery of technique which are essential; and with these professional qualities they must combine a breadth of interest and a literary skill which very few professionals possess. Finally, they must be *honest*, and set themselves resolutely against any attempt to catch an audience by making their subject cheap.

In this respect the attitude of the authors is irreproachable. They do not pretend that their book is all easy arm-chair reading, or is likely to have a wide vogue among "tired business men". They know very well that mathematics is a serious and sometimes an exacting discipline, and that anyone who wishes to master even a little of it must be prepared to face a certain number of uncomfortable hours. They have done their best to smooth the path, and on the whole with remarkable success; but they realize, and warn their readers honestly, that no one can learn anything worth knowing about mathematics unless he has "a certain intellectual maturity and a willingness to do some thinking on his own". Very little *knowledge* is required; no more than could be learnt from any good high-school course.

I can think of quite a number of classes of readers for whom the book is just adapted: really clever schoolboys of fifteen, freshmen undergraduates of average mathematical ability, secondary schoolmasters, university lecturers in physics and engineering, even a minority of philosophers. All of them (except the first) will find difficulties somewhere, but a book on mathematics without difficulties would be worthless. Finally, even professionals (though they will naturally skip a lot) will find the book well worth reading. Few of them will really know more than seventy per cent of the contents, and each will probably pick out for special praise the parts with which he is least familiar.

To me, for example, the best chapter is Chapter 5, on topology. Here are Euler's formula for polyhedra, the 'five colour theorem', Jordan's theorem (for polygons), Brouwer's 'fixed point theorem', and many suggestions of further developments. The proof of Brouwer's theorem, in particular, is a model of what a mathematical proof should be. Next I put Chapter 7 (on maxima and minima, with strong emphasis on the geometrical side): Schwarz's 'triangle problem', Steiner's 'road problem', the isoperimetric property of the circle, Bernoulli's investigation of the brachistochrone, and much other attractive matter. Here, on the fringes of the calculus of variations, Prof. Courant is naturally at his best as an expositor. It is a pity that the famous 'ham sandwich' problem should be a little too difficult to include: the two-dimensional analogue is solved in Chapter 6 as an application of Bolzano's theorem.

It is natural that I should find the arithmetical and analytical chapters less entertaining, but I have no serious fault to find with the authors' choice of material. There might perhaps be a little more about logic and 'fancy' algebras. The calculus comes late, in Chapter 8, but that I welcome: it will be good for 'practically minded' readers to learn that 'calculus for engineers' is nowhere near the centre of mathematics.

The chapter which I find the least satisfying is Chapter 4, on projective geometry, based as it is, like the accounts in the school-books, on ratios of lengths and other obviously metrical concepts. The geometers will agree with me, but the difficulty is fundamental, and I do not suggest that the authors are wrong in following (like Dresden before them) the course they take. The subject cannot be ignored but, treated really logically, in the manner of Veblen and Young or even of O'Hara and Ward, it becomes too bulky and formidable for a book like this. It is necessary to be rather illogical; but I think that the authors should have taken their readers a little further into their confidence, by the insertion of a few explanatory pages in which the difficulty is faced squarely. I would suggest this for the next edition: the explanations would demand great expository skill, but nothing which I should judge to be beyond the authors' powers.

I should add finally that the book is beautifully printed and the diagrams particularly well drawn.

G. H. HARDY.

ANALYSIS OF FOODS AND DRUGS

Aids to the Analysis of Foods and Drugs

By Dr. J. R. Nicholls. (Students' Aids Series.) Sixth edition. Pp. vii+424. (London: Baillière, Tindall and Cox, 1942.) 10*s*.

THE sixth edition of this well-known book requires no introduction, and it is a pleasure to note that Dr. Nicholls, who was responsible for so much good work in his revision of the previous edition, has now become the recognized author. This edition, which has been increased in size by about one third, contains several new sections; in addition, previously existing sections have been extended and revised. Many references to recent original work recorded in *The Analyst* and elsewhere have been included, and these alone make the book of great value to the practising analyst. The great majority of the new sections have been added to the chapters dealing with food; drugs now occupy only about a tenth of the book, an even smaller proportion than formerly. One might almost suggest that they could be omitted altogether; the book could then be removed from the "aids" series and published in more pretentious form as a text-book on food analysis.

Dairy products occupy the first hundred pages of the book. The statement, which has persisted from an early edition, that the total solids of genuine milk rarely fall below 12·2 per cent, would appear to require further explanation. The new section on vitamins deals briefly with each, giving the structural formulæ and references to the better established methods of assay; a short table at the end of the section gives the international unit and the sources of the better known. The appendix at the end of the book has been extended to cover the Food and Drugs Act 1938, and gives a short summary of the more important points likely to affect the food and drug analyst. A list is also appended of some of the more important regulations and orders governing food which have been passed since the War.

In his preface, the author perpetuates the statement originally made in the preface to the first edition, that the book is not intended as a cram book for the examination of the Institute of Chemistry in food and drugs. It might equally well be said that the student, if he uses the book as a guide and follows up the many references given, will find in it an excellent basis for the theoretical knowledge he requires.

J. H. SINGER.

Maps and Survey

By Arthur R. Hinks. Fourth edition. Pp. xiv+301+28 plates. (Cambridge: At the University Press, 1942.) 16*s*. net.

MANY of the older readers of NATURE will remember the thrills of excitement when the latest traveller returned to Great Britain with the story of some great discovery, but with a very meagre little map, as the secrets of the surface of the world were gradually unfolded. That epoch is now ended, but the art of surveying and of the making of maps continues to improve.

The issue of a fourth edition of Hinks's "Maps and Survey" is welcome, though, owing to military necessities, all the newer elements of military surveys cannot even be mentioned; Chapter 12, on photographic, including air, surveys, being left as it was nine years ago. The additions and corrections collected in Chapter 14 would have been more useful had they been printed on one side of the paper only, so that they could have been cut out and pasted on the appropriate page.

While the surveyor may learn to survey from Close's "Text-book of Topographical Surveying", his education would be incomplete without Hinks's book. The insoluble problem of the spelling of names is well treated, numerous difficult cases being quoted, notably that of the Grampians being called by the Russians Grampianski Gari, while we British in our turn are just as bad. The device mentioned on p. 47 of stamping typed names on to the drawing paper was the regular method employed by the Survey of India on all its maps except for engraved small-scale maps.

While methods of survey are rightly the preserve of the professional surveyor, the resultant map is essentially for map-users; the general public, therefore, is fully justified in making criticisms and suggestions as to the form, style and scales of maps they require. It is curious to read in these war days that it was the 1745 rebellion that made the British Government realize the need for accurate maps and was the cause of the inauguration of regular surveys in Great Britain. Even for a non-surveyor, this book, or at least the non-technical parts, is well worth reading.

What Price Alcohol?

A Practical Discussion of the Causes and Treatment of Alcoholism. By Dr. Robert S. Carroll. Pp. xv+362. (New York: The Macmillan Company, 1941.) 12*s*. 6*d*. net.

UNDER this somewhat unconventional title Dr. Robert S. Carroll, founder and medical director of the Highland Hospital, North Carolina, deals with the alcohol problem mainly from the psychiatrist's point of view. The book, which contains a preface by Dr. Adolf Meyer, emeritus professor of psychiatry at Johns Hopkins University, is divided into three sections entitled respectively "Why Alcohol?", "What Price Alcohol?" and "Alcohol or Man?" Recognizing as he does that there is no specific treatment for alcoholism owing to the great variety among the sufferers from this condition, the author advocates the elaborate study of each individual case, laying special stress on the importance of a daily association of the psychiatrist with the patient. He forecasts that the future progress of the campaign against alcoholism will be effected by an alliance of scientific searchers after truth and the avoidance of declamations against strong drink, while he suggests the creation of courses of mental hygiene for all types of schools and publicity sponsored by the State.

Other subjects discussed in this work are the biochemistry of alcohol, alcoholism in women, the relation of alcohol to sexual life, the treatment of benign cases and, most important of all, re-education. Drug treatment in the form of sedatives, morphia and its associates are regarded as unnecessary. The work is illustrated by the description of cases from the author's practice, some of which he has studied for fifty years.

The Life of Sir William Osler

By Harvey Cushing. Pp. xviii+1417+12 plates. (London, New York and Toronto: Oxford University Press, 1940.) 21*s*. net.

THE life of William Osler by Harvey Cushing, published in 1925, has held its place, and must continue to do so, as one of the greatest of medical biographies. The book under review consists of one volume instead of two, and contains, with unaltered text, only eleven of the forty-seven original illustrations. For these reasons it is less expensive than its forerunner and may well enjoy a wider circulation among medical students, to whose purses it is intended especially to appeal.

Cushing described his two volumes as a compilation of records put together in the hope that the story of Osler's life would tell itself through what he put on paper. Through this medium his personality, spirit and character were certainly revealed to the reader, but no attempt was made to appraise his professional accomplishments, considerable as they must prove to be when the final count is made.

Whether Drs. John F. Fulton and W. W. Francis, who are responsible for this new edition, will succeed in introducing it to as many students as they hope for may be in doubt. Even a single volume of nearly fourteen hundred closely printed pages is a formidable task to tackle, and yet another "Boswell" may one day abridge the text for another generation without decreasing its attraction and historical interest.

Both Osler and Cushing, who were intimate friends during twenty-five years, played prominent parts in the most productive era of clinical medicine in North America, the former by his unequalled personal charm and inspired leadership, the latter by his solid contributions to the advance of knowledge.

Allergy

Strangest of all Maladies. By Dr. Warren T. Vaughan. (Advancement of Science Series, No. 2.) Pp. 160. (London, New York and Melbourne: Hutchinson's Scientific and Technical Publications, 1942.) 10*s*. 6*d*. net.

THIS little book, as the subtitle states, is "a popular study of the causes and methods of treating asthma, hay fever, urticaria and other allergic diseases". Though primarily intended for the general reader, the work will be of service to many medical practitioners, who will be surprised by the author's interpretation of phenomena as allergic which they had previously attributed to some other cause. Examples of the kind are drowning and certain physical expressions of unrequited affection. The book is written in a humorous style, and the text is liberally interspersed by half-tones and line drawings of a correspondingly facetious character, which should facilitate the comprehension of so difficult a subject.

J. D. R.

TUBERCULOSIS IN PEACE AND WAR*

By Sir ARTHUR MacNALTY, K.C.B.

THE National Tuberculosis Service in Great Britain was established in 1912. This is an integral part of public health, and every measure calculated to promote the health and well-being of the community is a contribution towards it. It is a great machine of organization requiring constant overhauling, alterations and improvement. Thirty years have gone to the making of it, and these have not been unbroken years of peace.

Progress in the scheme's development was arrested by the outbreak of the War of 1914–18. War conditions associated with malnutrition or semi-starvation invite tuberculosis infection. Examples of high tuberculosis morbidity were seen in the enemy-occupied countries, and the present War is likely to show a similar incidence on an even more tragic scale. The disease is one of the camp followers of war.

The standardized death-rates per million living for pulmonary tuberculosis (England and Wales) rose from 988 in 1914 to 1,498 by 1918. Thereafter they fell. The main causes of this increase were contact infection, overcrowding, the breaking down of bodily resistance to infection through prolonged physical or mental strain, in some cases a lowered standard of nutrition and intercurrent infection, especially influenza. This is how tuberculosis spreads, and war conditions augment the rate of its progress.

My representations made in 1915 that military service would heighten the incidence of tuberculosis in the adult population, and that there would be an overwhelming demand for beds in sanatoria for ex-Service men and other workers, were justified after the War of 1914–18. The total number of ex-Service men invalided out of the Services on account of tuberculosis attributable to, or aggravated by, conditions of service, amounted, approximately, to 35,000, and provision had to be made for them as well as for civilians.

Great Britain had peace for twenty years, and in that period much was done to extend, improve and develop anti-tuberculosis work. Important features were:

(*a*) The surgical treatment of tuberculosis, including artificial pneumothorax, which has enabled successful treatment to be given to many intermediate and advanced cases of pulmonary tuberculosis, the arrest of whose disease was formerly regarded as either hopeless or problematical. It has also led to a more intelligent use of sanatorium and hospital treatment in relation to the individual patient.

(*b*) With this wider outlook and success in treatment should be associated the work done in tuberculosis by that great pioneer, Sir Pendrill Varrier-Jones.

(*c*) The improvement in X-ray technique and the consequent important aid afforded by X-rays in the diagnosis of pulmonary tuberculosis and in the control of collapse therapy.

(*d*) The close association of research work in tuberculosis with practical application.

(*e*) The Local Government Act of 1929, which made it possible to treat all necessitous cases of tuberculosis under the tuberculosis schemes of local authorities.

Let us look for a moment at the position in 1938, the last year of peaceful endeavour. All forms of tuberculosis were declining in our midst. In 1911 there were in England and Wales 38,422 deaths from pulmonary tuberculosis, a figure which in 1938 had declined to 21,930. The decline in deaths from other forms of tuberculosis was even more remarkable. In England and Wales in 1938 these deaths were 14,698; in 1938 they had fallen to 4,246. The prevention of contact infection, the increased pasteurization of milk, earlier ascertainment and skilled treatment, all no doubt had their effect in this remarkable result. It is bitter now to record that progress has for the second time in the history of the national tuberculosis scheme been retarded by the outbreak of a world war.

The baneful influence of war in favouring tuberculosis mortality is already revealed by the vital statistics of the present War. In 1939 the deaths from tuberculosis in England and Wales were 26,250. (War conditions only prevailed in a little more than three months of that year.) In 1940 they were 28,144 and in 1941 they had risen to 28,669. The increase would be greater if non-civilians were included. Comparing with the year from mid-1938 to mid-1939 as standard, the increase in deaths from respiratory tuberculosis amounted to about 6 per cent in the first year of war and 10 per cent in the second. Using the same standard of comparison, the increase in deaths from other forms of tuberculosis amounted to 2·4 per cent in the first year and 17·6 per cent in the second year. The bulk of this increase has been due to tuberculous meningitis; in the first half of 1940, deaths from this cause numbered 1,047, but in the first half of 1941 the total was 1,422, an increase of 375, while all other forms of non-respiratory tuberculosis showed a rise of only 41 (Stocks). For the first six months of 1942, deaths from all forms of tuberculosis were only 14,412 as compared with more than 16,000 deaths in the first half of 1941. This improvement has coincided with a lull in enemy attack.

In Wales alone no perceptible rise in deaths from tuberculosis was seen until the year 1941, and the total death-rates (tuberculosis, all forms) are lower than the death-rate for 1938. The population of Wales has increased while that of England has decreased by reason of war evacuation measures. The comparison must therefore be made with the greatest caution.

The death-rates from tuberculosis in Scotland per 100,000 were 70 in 1939, 82 in 1940 and 83 in 1941. The latter is the highest rate since 1932.

Through the courtesy of the director-generals of the Medical Services of the Royal Navy, Army and Royal Air Force, I am permitted to say that, as was anticipated, there has been an increase in tuberculosis in the Fighting Services since the outbreak of war. The incidence of pulmonary tuberculosis in the Army, so far as men are concerned, has shown no upward trend, and the incidence in the R.A.F. has been falling for the last six months. The increase noted does not mean that a healthy recruit is unduly exposed to contracting pulmonary tuberculosis. Service conditions may reactivate the disease or break down a poor resistance to the tubercle bacillus. With the introduction of conscription, tuberculosis in the Fighting Services is, as it were, a mirror picture of civilian tuberculosis. Furthermore, a Service man is under constant medical observation, and occult tuberculosis is more readily detected than in civilian life.

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* Substance of the Malcolm Morris Memorial Chadwick Lecture delivered on November 24.

At the outbreak of war, there was a temporary dislocation of the tuberculosis services in some areas. There was a shortage of residential accommodation, for some of the sanatoria had to be converted into casualty hospitals, and in the excitement of war conditions, in many instances, advanced and infective patients were sent home contrary to the instructions of the Ministry of Health. The Ministry was able later in the year to release 6,000 beds for the treatment of tuberculosis. In 1940 patients were removed inland from hospitals and sanatoria in the eastern and southern coastal areas under the threat of enemy invasion. During the intensive bombing of London and other large cities, many tuberculosis wards in general hospitals were put out of action. All this has added to the difficulties of adequate residential accommodation, although, as the Minister of Health pointed out in June 1942, the main problem is the shortage of nurses for the tuberculosis service.

Evacuation and shelter life also provided their problems. Arrangements were made to meet evacuated persons' needs for continuation of treatment, and efforts have been made by medical supervision and attention to hygiene to diminish the risk of spread of infection in the shelters. Since the War, there has been an increase in tuberculosis mortality in mental hospitals and mental deficiency institutions.

Experts have pronounced that the present scale of rationing is adequate for the tuberculous, if carefully planned, as in sanatoria and hospitals. The consumptive at home or in lodgings may not be able to secure such a diet, and many think a case for special nourishment can be made out on these grounds.

War conditions are, for many reasons, favouring uberculosis among all callings. In this increased incidence the factory workers share, but the primary causes of it lie for the most part outside the factory.

Measures of prevention and treatment may be grouped into immediate and future measures. The deadly effects of tuberculous milk are well known, and universal heat treatment of all milk would abolish tuberculosis of bovine origin, which is responible for about 2,000 deaths in England and Wales annually as well as much suffering, illness, crippling and economic loss. Miniature or indirect radiography is an important aid to early diagnosis, but it reinforces and does not supplant clinical examination. It must not be used as a 'rule of thumb' diagnosis. Recent work in chemotherapy encourages the hope that ventually a drug may be found which will destroy he tubercle bacillus in man (*vide* "Chemotherapy and Tuberculosis", NATURE, October 31, p. 517).

After the War, Great Britain will be faced with a greatly increased incidence of tuberculosis, paricularly in ex-Service men. It is high time to marshall all our forces, and the Ministry of Health is already taking active steps. More institutional provision and beds will be needed. The village settlement, which provides the ideal solution of the tuberculosis problem, and other methods of rehabilitation will be required. The Medical Research Council favours the setting up f a national board in order to co-ordinate the planning of a national rehabilitation scheme. This was first advocated by Sir Pendrill Varrier-Jones in 936. The work and direction of such a board is called for especially at the present time.

MATHEMATICS IN THE U.S.S.R.

By PROF. IVAN VINOGRADOV

Moscow (by cable)

THE development of the science of mathematics in Russia is comparatively recent, beginning with the establishment of the Russian Academy of Sciences in the eighteenth century, when Bernoulli and Euler, leading mathematicians of the time, were invited to Russia. These men, however, remained foreigners, and did not create what may rightly be termed a Russian school of mathematics. Lobachevsky was the outstanding Russian mathematician, and he first propounded theories of non-Euclidean geometry, but he did not found a school of mathematics, and his ideas were not taken up by any pupils.

The real foundation of a Russian school of mathematics dates only from the latter half of last century, beginning with the work of Chebychev. Russian mathematics began at once to develop on three separate lines: the theory of numbers; the theory of probability; and the theory of approximation, the latter owing its origin to Chebyshev himself. Following on the heels of Chebyshev came a whole generation of brilliant mathematicians, among whom were Zolotaryov, Korkin, Markov, Voronoy, Lyapunov, and Steklov, whose work was in the main on the theory of numbers, the theory of probability and analysis. It was thus a characteristic of the Russian school of mathematics that its members were engaged mainly on the solution of practical mathematical problems, and generalized theories were built up on the basis of the investigation of concrete problems.

This tradition of concreteness and at the same time great profundity of investigation dates back to the time of Lomonosov, and has marked most of the work of Russian scientific men. Their research work did not follow the lines of existing scientific knowledge, but broke new ground for itself.

Shortly before the Revolution in Russia, mathematics branched out in a new direction, basing itself on the work of French mathematicians and dealing with the more abstract theory of analysis. The founders of this school were Luzin and Yegorov, after whom came a number of their brilliant pupils.

Since the Revolution the development of mathematics has been particularly successful, and Russian mathematicians have taken their place in the front rank in diverse realms of mathematical science. The first place is occupied by the theory of numbers, which, thanks to the work of Chebyshev, Markov, Voronoy and others, had already reached a high level in Russia and to which has since been added original work by Delone, Chebotarev, Helfond Schnirelman, Vinkov, Vinogradov and others. Russian mathematicians now occupy a leading place so far as the theory of numbers is concerned. The investigations of Chebyshev, Markov and Lyapunov have played a leading part in the development of the theory of probability, and their work has been maintained by Russian science, thanks to the work of Bernstein, Kolmogorov and Hinchin.

The abstract side of Russian mathematics soon liberated itself from foreign dependence and reached a level such that the eyes of mathematicians abroad began to turn towards Moscow, thanks to work on abstract mathematics by Luzin, Suslin Uryson, P. Alexandrov and others. This side of mathematics began to develop on concrete and at the same time general problems in the newest branch of geometry, namely, topology, and on problems in algebra and analysis allied to it. New and important results in this field have been obtained by Pontyagin, P. Alexandrov, Kolmogorov and others.

The work of Russian mathematicians on analysis has many-sided characteristics. The qualitative theory of differential equations, which has numerous applications in astronomy, electricity, and so on, was dealt with before the Revolution in profound and original work by Lyapunov. This field has been taken up by N. Krylov, Bogolyubov and others. In the general theory of differential equations great progress was made before the Revolution, as is recorded in works of Steklov and Bernstein, and since by Alppo-Danilevsky as well as by Petrovsky and Sobolev.

The application of methods of mathematical analysis to problems in mechanics, the theory of elasticity and hydromechanics has given very important results, as can be seen in the work of A. Krylov, Muskhalishvili and Lavrientyev, the last-named having propounded an important general theory concerned with the functions of a complex variable. More recently, a young Soviet scientific worker, A. Alexandrov, by the application of new methods, has produced important new geometrical results.

We cannot in this short article describe in anything like detail the many and varied achievements of Russian mathematics during the twenty-five years which have elapsed since the October Revolution. We propose to deal here only with some examples of pure mathematical investigation in algebra and geometry.

Algebra, which may be defined as the science of the abstract study of operations in addition and subtraction, can be carried out not only with numbers but also with vectors, oscillations in alternating current circuits, etc. Every combination the elements of which can be subjected to the operations of addition and subtraction is called a cumulative group. From this it can be seen that the study of cumulative groups is of extreme importance. The problem requiring solution was the explanation of the properties of continuous cumulative groups and a method of investigating them. This problem was first solved by the Russian scientific worker, L. S. Pontyagin, with the aid of a method which he originated and which has since been successfully applied to other branches of mathematics.

Geometry is the science of figures, and although many geometrical problems are subject to visual proof, their solution is nevertheless often very difficult. In 1916, the well-known mathematician, Weil, propounded a fundamental problem of convex surfaces which he himself could not solve in its entirety. In 1940, A. Alexandrov showed that Weil's problem could be solved as a special case, and developed a new general method in the theory of surface areas. The fundamental part of the results obtained by Alexandrov is his discovery of a theorem of polygons which, though simple to formulate, is far from simple to prove. This theorem makes it possible to build up a convex polygon from pieces of paper cut to certain shapes. It may seem strange that what is at first sight an interesting problem for a child should be the basis of profound geometrical theories. Even such a problem, however, offers the greatest difficulty in solution.

Apart from purely theoretical investigations, Russian mathematics pays considerable attention to the solution of problems of an immediately practical character. Among problems of this nature we may point to research in the theory of the aeroplane, particularly by Christianovich and Keldysh, to work on rational laws of gunfire, on the movement of a shell, on the calculation of dams by Senkov's system, and other similar problems. At the present moment, when the U.S.S.R. is carrying on a great struggle against Fascism, these problems are of primary importance and occupy many of our leading mathematicians. It would be interesting to deal with these problems in greater detail, were it not for the fact that their significance in the present War compels us to keep them secret.

From this very short sketch, it can be seen that Soviet mathematics has attained a very high level. There are in the Soviet Union a number of outstanding mathematicians working in all realms of mathematics, and there is our own original school of mathematics, which, although it omits various branches, makes it certain that further development of the science of mathematics lies ahead in the U.S.S.R.

APPLICATIONS OF PHYSICS TO THE HEATING AND VENTILATION OF BUILDINGS*

By A. F. DUFTON
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> "The subjects of warming and ventilating, although in themselves simple, still deal with things and motions which are impalpable and invisible, and must be studied in their principles to be understood at all. Where the bodily eye can see nothing the mind's eye must note important processes. The peculiarity of the subject is proved by the fact of so many distinguished architects and engineers failing signally in undertakings to warm and ventilate."—Neil Arnott.

SO early as 1784, James Watt used steam for warming the room in which he commonly wrote, and his radiator, a box three and a half feet long, two and a half feet wide and one inch thick, was made of tin plates. The warming effect of this radiator, however, was less than he anticipated. The fact that Watt's expectations were not fulfilled serves as a reminder that engineering is, in a great measure applied physics and that practical advances follow as and when progress is made in experimental physics We now know that the radiator of 1784 did not emit sufficient heat because its surface was metallic, but it was not until 1801 that John Leslie discovered the nature and ascertained the properties of what is termed radiant heat.

Leslie found that the application of a coat of pigment to a metallic surface, instead of retarding the discharge of heat, nearly doubled it. He remarked that this fact, equally curious and important, was most contrary to the prevalent notions, and seemed not to have been hitherto observed. He showed that a tin canister, filled with hot water, cooled considerably faster after it was covered with flannel, and required the further addition of one or two folds to make it cool at the same rate as before. "These remarkable facts," he declared, "bid defiance to the loose sort of philosophy, which, without requiring any exertion of mind, pretends to explain everything. They teach us the necessity of a sober scepticism and demonstrate the great utility of extending a critical inquiry into the various popular branches of physics."

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* From a lecture delivered before the Institute of Physics on November 17.

Radiant heat is not a simple entity and we must distinguish, for example, between the radiation which we receive from the sun and the radiation from bodies at temperatures of, say, 0°–100° C. The wave-lengths of the radiation we receive from the sun are all less than $3{\cdot}0\,\mu$, and the wave-lengths of the radiation from a body at low temperatures are all greater than this.

It is interesting to recall that the infra-red rays were first discovered by Sir John Herschel in the course of a research into the properties of various kinds of coloured glass, undertaken with the view of the selection of suitable glass for use in viewing the sun through a telescope. He wished to discover which of the sun's rays furnished the greatest quantity of light without inconveniencing the eye with unnecessary heat. He observed that the heat became more and more considerable as a thermometer was moved towards the red rays in the solar spectrum, and found not only that the heat continued beyond the limit of the visible spectrum but also that it was there more intense than at any point within the spectrum.

The diathermanous power of a substance differs greatly with the heat from different sources. Glass is a notable example. It transmits freely the heat of the sun, but intercepts all the radiation from a source at a temperature below 100° C. This property of glass enables us to trap the sun's heat in greenhouses and in dwellings. Glass transmits only six per cent of the heat emitted by a source at 400° C.

It must be emphasized that, in general, the absorbing and reflecting powers of a surface for low-temperature radiant heat are different from the corresponding absorbing and reflecting powers for solar radiation. Ignorance of this has led to much confusion, since the property which bodies possess of absorbing, emitting and reflecting radiant heat meets with many applications. In that old text-book, Ganot's "Treatise on Physics", we are told that the outsides of stoves and hot-water apparatus ought to be black, to give free exit to the heat. This is quite erroneous; the colour of the paint makes no difference to the emission of heat from hot-water apparatus so long as the paint does not contain metallic flakes. Metallic paints, such as aluminium and bronze, vary somewhat, the average emissivity being about 50 per cent. An appreciably lower emissivity than this is said to be obtainable, presumably by taking care not to cover the metallic flakes with too much of the binding material. In the case of an ordinary cast-iron radiator, painting with aluminium paint is found to reduce the emission by about 10 per cent; the heat communicated directly to the air, which in the case of an ordinary radiator is greater than that emitted as radiation, is unaffected by the nature of the paint used.

When we remember for how long buildings in Great Britain have been heated by means of open fires, it is difficult to understand why so much reliance has been placed upon radiant heating and why the air-warming fireplace has never become popular. Such a fireplace heats a room by means of convection currents, the heat imparted to the air causing it to circulate throughout the room. Of the experimental physicists who have advocated such fireplaces the best known is probably Benjamin Franklin, who in 1745 described his newly invented "Pennsylvanian fireplace", by the use of which he reckoned to save no less than five sixths of the fuel required to heat a room. The Pennsylvanian fireplace was preceded by the fireplaces of M. Gauger, who in 1713 published a treatise on the subject which was translated into English by a physicist, Dr. Desaguliers, and published in 1716 under the title "The Mechanism of Fire made in Chimneys".

Some four years ago I contrived an air-warming fireplace in my own home and now obtain probably three times as much useful heat from the fuel burned as before. Even in midwinter, with snow lying, there is no difficulty in heating the room so that at a distance of 20 ft. from the fire the air temperature is 70° F. This fireplace is an adaptation of the "Cheminée de Nancy" of two centuries ago.

When heating is intermittent, as is frequently the case, it is important to reduce the heating-up period to a minimum, both for economy and convenience. The problem is a physical one, and the basis for the necessary analysis was laid by Baron Fourier in his "Traité de Chaleur". It is now clear that for the most efficient use of intermittent heating the walls of a room should be lined with wood or other insulation of small thermal capacity; I believe that my experiments were the first to illustrate this. I measured the rate of warming of a room in my own home before and after I lined it with oak panelling. Without taking the furniture into account, only half the boundary surface of the room was changed by the panelling—the ceiling, window, floor and door were not affected—yet the change in the room was remarkable. The room is now warmer after half an hour than it used to be after an hour and a quarter's heating. From the practical point of view the important fact is not that one hour's heating now suffices instead of two, but that a fire may reasonably be lit half an hour before the room is wanted.

To turn now to the applications of physics to ventilation. In order to ventilate a room, an aeromotive force is necessary and the movement of air must be properly directed and controlled, especially if draughts are to be avoided. To illustrate how this may be done it is of interest to see how a physicist ventilated his house and, as an example, I cite Sir John Robison's house in Randolph Crescent, Edinburgh, and quote from the description given in 1839 by John Milne, an Edinburgh architect.

"The system of ventilation employed in this house appears to be as perfect as can be desired; as while the mass of air in the rooms and passages is constantly undergoing removal by the escape of vitiated air above, and the admission of large supplies of fresh air from below, no currents are perceived in the apartments, which, even when crowded with company and amply lighted, preserve a remarkable freshness of atmosphere. . . . This is effected by means of cylindrical flues of earthenware, nine inches in diameter, built into the gables, in close proximity to the smoke flues of each room. The lower ends of these ventilating flues open into spaces between the ceilings of the respective rooms and the floors of those above them; and there is one or more of these exit air-flues in each room according to its size and use. The heated and vitiated vapours pass upwards through the ceilings by a continuous opening of about one inch and a half wide (behind one of the fillets of the cornice) all round the rooms, and having thus passed into the space between the ceiling and the floor immediately above, they ascend by the flues in the wall, and are discharged by them into the vacant space between the ceilings of the attics and the roof; from whence they find their way through the slates to the open air. The passage for the air through the cornice is not visible from the floor of any of the rooms. . . . The continued supply of fresh air to the lower part of the house, to replace that which goes off by the ventilators and by the chimneys, is brought in from the garden behind the house by a passage, the sectional area of which is eight superficial feet. The cold air admitted by this passage (or by a similar one from the front of the house) is made to pass over a stove. . . . The usual temperature of the air issuing from the stove is as low as 64°. The whole of this air is discharged into the well of the staircase, which forms a reservoir from which the rooms draw the quantity required to maintain the upward currents in the chimneys and in the ventilating flues. The air in the staircase finds its way into the apartments by masked passages, of four or five inches wide and four feet long, over the doors, and by openings left under each door of about one inch wide. The sectional areas of these passages are more than equal to the areas of the chimney and ventilating flues . . . the quantity of escape is regulated by hand by means of throttle-valves at the mouth of each escape-flue. . . ."

It is interesting to note that, when asked in 1841 whether experience had suggested any alterations or improvements, Robison replied that, if the house were to be built again, the only difference he should make would be to form the air-passages still wider. To return to the present century, I can testify that one of the pleasantest living-room atmospheres which I have experienced was in a room provided with a ventilated cornice.

The temperature of a room with air and walls at different degrees is not easily specified. From the point of view of comfort, it is the rate at which heat is lost from the body which seems to be important, and the equivalent temperature of an environment is defined as that temperature of a uniform enclosure in which, in still air, a sizable black body would lose heat at the same rate as in the environment, the surface temperature of the body being one third of the way between the temperature of the enclosure and 100° F. The scale of equivalent temperature, introduced by me in 1929, is essentially a refinement of the sensation scale; it is measured by a eupatheoscope. When the instrument is placed in a room with air and walls at, say, 62° F. and the air is still, it indicates 62° F. If there is a draught of some 200 ft. per minute in the room, the instrument 'feels colder' and indicates 56°. The eupatheoscope is primarily an instrument for research.

Heating engineers are dependent to a great extent upon rule-of-thumb and in this age of progress are finding some difficulty in adapting standard practices and calculations to meet modern requirements. In the Heating Laboratory of the Building Research Station at Watford, we have a room with walls, ceiling and floor exposed to controlled conditions, and it is possible to study not only different methods of heating, the problems of intermittent heating and the influence of ventilation upon heating, but also those phases of building construction of interest to heating engineers. The temperature of the air in the enclosure is controlled by means of an extensive system of panel-warming and panel-cooling pipes in the walls, floor and ceiling. This enclosure is defined when the temperatures of the various surfaces are specified. The walls of the enclosure are heated or cooled by means of calcium-brine pumped through the embedded pipes, and the mean surface temperature of each wall is individually controlled to 0·1° F. by a copper resistance thermometer in conjunction with a sensitive relay system. Each wall-surface is tested once in every six minutes and the controls then automatically raise or lower the temperature of the brine by means of specially designed modulating valves.

The laboratory is designed for comparative work, and the most common form of heating in use at the present time—by cast-iron radiators—has been chosen as a standard of reference. This not only provides a convenient yardstick but also ensures that a substantial body of data is obtained about this important type of heating. The Institution of Heating and Ventilating Engineers has taken a great interest in the work at the Building Research Station, and there would have been no Heating Laboratory without the help of the Institution.

To many people the applications of physics which are of particular interest are those concerned with the development of automatic mechanisms. In this connexion I would like to invite attention to the contributions made by Dr. Neil Arnott, who was not only an eminent physician but also a competent experimental physicist. It is a hundred years ago now since Arnott produced his 'thermometer stove', the temperature of which was directly controlled by a thermometer. He applied also the unequal expansion of two small bars, one of iron, the other of brass, to the control of the air supply for a stove; but his most elegant device was the 'balanced valve regulator' which he used to regulate stoves and boilers; one of which served a small steam engine which worked a ventilating pump for months, night and day, having the attention only of a gardener, who put a supply of coal into the hopper morning and evening. With this regulator the air-flow is determined by the pressure exerted upon a plate. The weight placed on the steelyard is a measure of the quantity of air admitted to the fire and, with uniform combustion, a measure of the quantity of fuel consumed and of the heat produced.

I have mentioned a few of the physicists who have made practical contributions to the arts of heating and ventilation. Of all that has been achieved, however, in the field of heating research, there is nothing which quite compares with the work of Count Rumford. He was a great experimenter and devised methods of measurement and made determinations not only of the specific heats of various substances and the thermal conductivities of insulating materials but also of the calorific values of fuels. He strove to find out how to heat and light buildings economically and well. This was a subject which he had much at heart, and when he founded the Rumford Medal of the Royal Society, he wrote to the president:

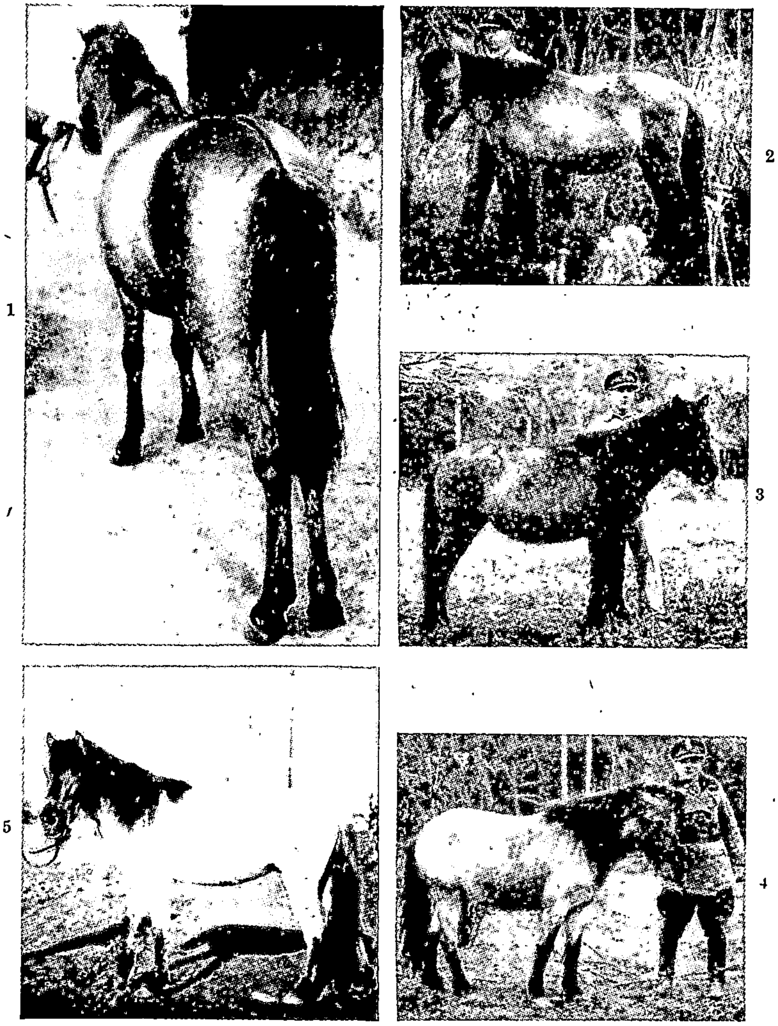
"The objects which I had more particularly in view to encourage, are such practical improvements in the generation and management of heat and light as tend directly and powerfully to increase the enjoyments and comforts of life, especially in the lower and more numerous classes of society."

THE WILD HORSE OF POLAND

By T. JANIKOWSKI

Formerly of Warsaw

WHILE studying the literature of the fossil remains of Scottish prehistoric animals I came across many interesting data recorded by the eminent Edinburgh zoologist, Prof. J. Cossar Ewart, on the subject of the hypothetical wild 'forest horse' of Scotland. According to Ewart it must have been "a stout horse with a heavy mane and tail, short strong legs, thick fetlock, joints and hoofs", a "type to which belong many of the stout, short-necked, round-quartered, deer-stalking ponies of the Scottish Highlands", with a face that is "broader and at the same time shorter . . . the outline of the face being concave". Until recently, the existence of such an animal, either in the history of man or in prehistoric times, lacked satisfactory proof. In view of the uncertainty concerning the Scottish 'forest horse' I should like to record certain facts about an interesting type of horse which still exists in Poland. This horse, the so-called *konik* (literally 'little horse' or 'pony'), formed the subject of an extensive study by Prof. T. Vetulani, of the University of Poznań, and also later by Prof. S. Hiller, of the University of Wilno (Vilna).



(1) THE BILGORAY "KONIK", WITH THE CHARACTERISTIC BLACK STRIPE ALONG THE BACK. (2) THE STALLION "TREF" IN AUTUMN, BEFORE TURNING WHITE. (3) THE MARE "CZAJKA" IN AUTUMN. (4) THE MARE "CZAJKA" IN WINTER. (5) THE STALLION "TREF" IN WINTER.

The *konik* is a small domesticated peasant-horse common in the district of Bilgoray, about lat. 50½° N. and long. 22¾° E. It is of a mouse-grey colour with a black stripe along the back from the mane to the tail. It can live remarkably long and still retain its vigour. Indeed, Vetulani reported having seen a pony still hard at work at the age of twenty-six years. The *konik* differs from the steppe horse in several aspects, having well-rounded body lines, an abundant mane and tail, relatively short limbs, a small height, a characteristic 'dished' or concave profile of the skull, a face which is remarkably short in comparison with the cranium and with the width of the forehead. Generally speaking, its features are strongly reminiscent of those typical for Ewart's horse. On the other hand, however, the *konik* bears some resemblance to still another extinct horse, the steppe tarpan (*Equus caballus gmelini* Ant.). The structure of the cheek teeth, and especially the width of the chewing surface as well as the simplicity of the enamel patterns, point to the oriental origin of the *konik*. The tarpan resembled the mouse-gray Bilgoray pony in its colour, its short dished face and some other marks, but differed in its lighter build, higher and more slender limbs; it also had a shorter and erect mane and no forelock. Taking all this into account, Vetulani arrived at the conclusion that the *konik* must be related to two varieties, the wild steppe tarpan, extinct at the end of the last century, and a second, unknown variety which possessed the features of the 'forest horse' of Ewart. He therefore introduced a new name for the Polish *konik*, the 'forest tarpan' or *Equus gmelini* Ant. *forma silvatica*, and he pictures the origin of the *konik* in the following manner.

With the onset of steppe conditions in Europe—in the glacial period and later—the steppe tarpan spread from the steppe bordering on the Black Sea to central and north-west Europe. However, the dry steppe climate did not last for ever. Gradually it became moister, and forests replaced the great grassy regions. The tarpan, an animal adapted to the conditions prevailing in the vast prairies, had to retreat step by step from the north-west to the Black Sea regions of its ancestors, where it remained as a living wild animal until 1880. In that fatal year the last tarpan lost its life after a fierce chase by hunters (Antonius). Of the tarpans which did not return to the Black Sea shores, some must have lost their lives because of the severe weather conditions. Others, more persistent and hardier, became inured and adapted themselves to the new conditions of life in the forest, undergoing gradually modifications in their bodies and developing at last into the new forest horse. Fossil remains of the latter are found throughout all central and north-west Europe, together with the remains of other members of the forest fauna such as the red-deer, roe-deer, boar, wild cat and elk.

A close examination of these remains reveals striking differences from the original tarpan; a shorter face and shorter limbs, two peculiarities which we also find in the mouse-grey *konik* as well as in some breeds of Scottish ponies. According to Ewart, "of a hundred Shetland ponies examined . . . twenty-five had most of the points of the Forest Variety". The two peculiar qualities, the brachycephaly and the micromely, are often thought to be connected with changes of the pituitary body. The hypophysis, which was of cord-form in the steppe tarpan type, became broader in the forest Bilgoray pony; the basis of the gland became flatter and developed a depression in the anterior part. Corresponding to this the sella turcica has changed also. From a regular pit it became irregular, with a convexity in the anterior part. In its inner structure the pituitary body of the forest *konik* shows a reduced amount of the glandular substance of the anterior lobe. According to Vetulani the climatic influences induced these changes in the hypophysis first, and the changes in muscular tissue followed in consequence. A strong development of the muscles with thicker muscular fibres and a higher content of the intramuscular connective and adipose tissue must have had a decisive influence on the bones.

Historical records show that the district which was inhabited originally by the wild forest horse, from which later the domesticated Bilgoray pony developed, was the Great Forest of Bialowieza, about lat. 52¾° N. and long. 24° E. This famous forest was visited in the eighteenth century by the Frenchman Hacquet, who saw the living wild forest horse with its short and erect hair of the mane and described it in his work published in 1794. The nineteenth-century Polish author Kozmian records that the wild forest horse of Bialowieza was brought at the end of the eighteenth century into a private forest zoo-park of Count Zamoyski near Bilgoray. One winter, at the beginning of the nineteenth century, when the cold was uncommonly severe, the horses, until then living free, were captured and distributed among peasants of the neighbouring villages, where, tamed and crossbred, they gave rise to the mouse-grey peasant ponies, a considerable number of them retaining the pure blood of their wild ancestors.

In 1936 Vetulani made an attempt to breed the forest horse back to its wild state. Among the animals which were brought back to the Great Forest of Bialowieza, a Polish national park, were the stallion "Tref" and the mare "Czajka", both of which had the remarkable and unique property of turning *white* in winter in a manner characteristic for certain other animals such as the hare, grouse and ermine. Every winter they changed the mouse-grey summer coat, distinguished by the black stripe on the back, into a snow-white coat, only the face, fetlocks, mane and tail retaining the dark colour.

After three years of breeding the number of horses in the Bialowieza Park rose to eighteen, out of which eight have been born free in the forest. Some of them inherited the property of becoming white in winter. According to Vetulani, the enigmatic wild white horse described by Herodotus as grazing in the northern marshy land may well have been the Polish wild pony grazing in the Polesie bogs situated close to the Bialowieza Forest.

It may be regarded now as definitely established that: (1) the 'forest horse' postulated by Ewart existed in olden times as a wild animal in many a forest of north-west and central Europe; (2) its last true wild descendants lived in the Great Forest of Bialowieza in Poland until the latest decades of the eighteenth century; and (3) some of the living wild forest horses were brought into a forest park and were later domesticated and to a certain degree cross-bred.

HIGH-CONCENTRATION HYDROGEN CYANIDE FUMIGATION OF FUNGI AND BACTERIA

By DR. N. POLUNIN

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THE highly toxic effects of hydrogen cyanide on animals are almost proverbial, and it is now well known that its main action causing their death is through interference with the respiratory enzymes[1,2]. Since these systems appear in general to be similar in animals and plants (including yeasts and bacteria[3]), the chief of them being found in representatives from all of the plant and animal phyla[4], it might be expected that exposure to hydrogen cyanide would also kill plants easily. So far is this from being the case that hydrogen cyanide 'fumigation' is commonly employed as a means of killing insect pests on greenhouse plants which are little if at all adversely affected by the process; it is also extensively used in plant quarantine and against scale insects of citrus trees[5]. Even as it appears that a high rate of respiration is more important than the size factor in determining the susceptibility of different animals to the higher concentrations of hydrogen cyanide[6], so it now seems likely that the usually greater resistance of plants to hydrogen cyanide is largely bound up with their generally much slower rate of metabolic activity.

Fungi and bacteria being "amongst the most actively respiring plants"[7], one might have expected them to be relatively easily affected by hydrogen cyanide were it not, perhaps, for their frequently high content and rate of turnover of sulphur[3,8]. For, in low concentrations, hydrogen cyanide, even if application is prolonged, may have little or no ill effect upon living organisms, owing to its being rapidly "converted into harmless combinations with the aid of sulphur supplied by compounds of albumen"[5]. However this may be, and in spite of the fungicidal and bactericidal properties of gaseous hydrogen cyanide being "extremely poor" in such concentrations and over such times of application as have usually been tried[5,9], the following observations show that in heavy doses hydrogen cyanide can be lethal to both colonies and spores (or other disseminules) of such moulds and bacteria as were to be found in the air of two rather dusty rooms. Considering the effect of fairly high concentrations of the gas on green plants[5,10] this was indeed to be expected but surprisingly enough does not appear to have been previously observed or at least not adequately recorded.

The observations referred to were made in connexion with the recent fumigation by a London firm of two rooms in our Druce Herbarium in North Oxford. This fumigation was principally against the drug-store beetle, *Sitodrepa panicea* (Linn.), and lasted about fifty hours. The concentration of gaseous hydrogen cyanide aimed at was in excess of thirty mgm. per litre (about 2·6 per cent 'by vol.'); some such maximum was probably reached within the first hour in the larger free spaces, but with little doubt the concentration in the atmosphere thereafter fell markedly owing to leakage and absorption[11]. The weather was favourably warm, throughout, though the temperature was slightly below normal for August, while intermittent rain kept the relative humidity high. For the observations malt agar Petri plates were prepared in considerable numbers by my colleague Dr. W. H. Wilkins, to whose assistants, Dr. G. C. M. Harris and Mr. Cripps, my sincere thanks are also due; Dr. Wilkins also kindly supplied the cultures mentioned below. Although most of my experiments were replicated either six or ten times by the use of as many plates, so that a considerable area of nutritive surface was exposed and incubated for each observation, it must be noted that apart from some germination tests performed later the only medium used was malt agar, which does not preclude the possibility of exceptions to these observations being afforded by organisms which do not normally grow on this very good 'all-round' medium (for example, at 25° C.).

Three days before the commencement of the fumigation, malt agar plates were exposed for ten minutes in various parts of the rooms concerned. After incubation for sixty-eight hours at 25° C. these plates supported from six to twelve evident fungal and bacterial colonies each. A few of the plates were left in the incubator as controls, but the majority were exposed, together with a number of fresh sterile plates and others supporting vigorous cultures of *Penicillium frequentans* Westling and *Aspergillus* sp., in various parts of the two rooms throughout the *c.*50 hours of the fumigation, before the beginning of which the air in the rooms had been rendered dusty by the shifting of herbarium material and furniture. In spite of the prevailingly favourable conditions of temperature and relative humidity, it appeared at the end of the fumigation that the 'exposed' colonies had not grown at all during its course; nor was there any sign of growth on any of the previously sterile plates. All these plates that had been exposed during the fumigation were now incubated at 25° C. for five days and nights, at the end of which period the results still appeared the same, that is, the previously sterile plates bore no sign of life while all colonies remained the same size as at the beginning of the fumigation. (A striking contrast was afforded by the plates that had been left in the incubator as controls instead of being exposed during the fumigation; dense growths now practically filled all these.) Before replacing in the incubator the infected plates which had been exposed to hydrogen cyanide, fresh sterile plates were inoculated from a number of the colonies on them; also, plates which had been sterile when exposed to hydrogen cyanide were so inoculated while other such plates were inoculated from vigorously growing cultures of several different moulds and one bacterium. After incubation for three days and nights there was no sign of growth in any of these cases, though quite large colonies had by this time developed on the pertinent controls (fresh plates inoculated at the same time from growing cultures). Nor was there yet any sign of life on any of the other plates that had been exposed during the fumigation, and, in some instances, afterwards aired with the covers off (these covers probably had little effect on the retention of any residual hydrogen cyanide by the medium[12]); nor would spores from these 'exposed' colonies germinate even much later in hanging drops of distilled water.

The conclusions thus seem inescapable that the colonies had all been killed by the fumigant and that the malt agar plates had all been rendered inhibitant to growth—at least of such saprophytic and aerobic fungi and bacteria as had been represented by spores in the air of the rooms. This inhibition lasted at least eight days but began to disappear thereafter; thus ten days after the cessation of fumigation a slight growth was observed from contaminations or fresh inoculations on some of the plates that had been exposed to hydrogen cyanide, though others appeared incapable of supporting growth even from any spores present in the air of the laboratory until several more days had elapsed.

It will be noted that, unfortunately, it was not determined whether the colonies were killed by gaseous hydrogen cyanide or by that adsorbed by the agar gel (the *p*H of which was probably not affected[9]), though the appearance and texture of dense growths of mould after the fumigation suggested that the gas alone had sufficed to kill them. Again, the spores of the air may merely have been unable to germinate on the surface of the 'exposed' medium —although those belonging to the colonies appeared to have been killed outright by the gas. These and most of the other obvious doubts could easily be settled by *ad hoc* investigation. But meanwhile the possibilities of useful application of such a method for the apparent sterilization of an entire system of rooms and their bulky contents are not inconsiderable, especially if damp colloidal material remains inhibitant to the growth of destructive saprophytic organisms for 1–2 weeks as did the agar plates in my observations. As examples we may consider how frequently nowadays tobacco is so mouldy as to be practically worthless when bought, and how much valuable material has been lost in bombed museums and stores because it was soused by rain or firemen's hoses and could not be dried before going rotten; fumigation, even if not long maintained, might well delay decay until all could be effectively handled and dried. For such purposes the practicability and relative merits of other fumigants should be investigated immediately (unfortunately sulphur dioxide, which is known to be more toxic[9] to fungi and bacteria than hydrogen cyanide, could not be used in herbaria, etc., owing to its bleaching action). A probable advantage of hydrogen cyanide is that in general bacterial growth is checked by very dilute solutions of it[6,13], while residual traces are very persistent[12] although the gas is notoriously penetrating; a disadvantage may lie in the uncertainty of any action on anaerobes which lack cytochrome components[3,4] but are able to break down carbohydrates[14]. From all these points of view the possibilities and limitations of formaldehyde should be further explored.

[1] Oppenheimer and Stern, "Biological Oxidations", The Hague (1939).

[2] Green, "Mechanisms of Biological Oxidations", Cambridge (1940).

[3] Stephenson, "Bacterial Metabolism", Ed. 2, London (1939).

[4] University of Wisconsin Biochemists (Arnold *et al.*), "Respiratory Enzymes", Minneapolis, Minn. (1939)—see also various papers by Keilin and his collaborators in *Proc. Roy. Soc. London*, Ser. B, from **98**, 312 (1925).

[5] Frickhinger *et al.*, "'Degesch'-Methods for Pest Control", Frankfurt (1937).

[6] Barcroft, *J. Hygiene*, **31**, 1–34 (1931).

[7] Stiles and Leach, "Respiration in Plants", London (1932).

[8] Zellner, "Chimie der höheren Pilze", Leipzig (1907)—see also Hasenöhrl and Zellner, *Akad. Wiss. Wien*, Mat.-nat. Kl., Sitz. Abt. IIb, **130**, 479–499 (1921).

[9] McCallan *et al.*, *Contr. Boyce Thompson Inst.*, **11**, No. 5, 325–342 (1940)—see also Tomkins, *Proc. Roy. Soc. London*, Ser. B, **111**, 210–226 (1932) and Proctor and Nickerson, "Fungicidal Properties of some Food Fumigants" (paper read at the New York Convention of the American Chemical Industry, April, 1935, but apparently never published; made available to me through the courtesy of Imperial Chemical Industries, Ltd.).

[10] Thornton and Setterstrom, *Contr. Boyce Thompson Inst.*, **11**, No. 5, 343–356 (1940).

[11] Page, Lubatti and Gloyns, *J. Hygiene*, **39**, 12–34 (1939)—see also "The Principles of Fumigation of Insect Pests in Stored Produce", H.M. Stationery Office, London (1941).

[12] Page and Gloyns, *J. Soc. Chem. Ind.*, London, **55**, 213T–217T (1936).

[13] Paul, Birstein and Reuss: various papers in *Biochem. Zeitschr.* from **25**, 367 (1910).

[14] Waksman, "Principles of Soil Microbiology", Ed. 2, London (1931).

OBITUARIES

Mr. William R. S. Ladell

Mr. William R. S. Ladell, whose sudden death in Jamaica on November 6 has just been reported, was born in 1887 and educated at the Merchant Taylors School and Finsbury Technical College. Before completing his degree, he went abroad and started work on agricultural science in the tropics, which was to occupy the greater portion of his life. After three years in South Africa with the Department of Agriculture, part of which was at the Cedara Experimental Station, he accepted in 1912 a position with a commercial company in Malaya, where he carried out many field and laboratory experiments on rubber cultivation. During the War of 1914–18 he served at first in the Far East and later in Great Britain and reached the rank of major in the Royal Army Ordnance Corps.

After the War, Ladell took up an official appointment in Siam and in 1923 was put in charge of the newly formed Bureau of Agricultural Science. The greater part of his work for the next twelve years was connected with problems of rice cultivation, in which he obtained a world-wide reputation. During this period also he developed a keen interest in general natural history, particularly entomology, and was for many years honorary secretary of the Natural History Section of the Siam Society.

In 1934, owing to the disturbed political situation in Siam, Ladell returned to England and worked for four years in the Entomology Department at Rothamsted on problems of soil insects and insecticides. His wide experience and chemical knowledge was here a great asset and he developed the method of separating insects from the soil by flotation in a heavy solution.

In 1938 an opportunity occurred for Ladell to return to the tropics, where his heart was always, and he became agronomist and soil chemist to the West Indian Sugar Company in Jamaica. There he found congenial work, and shortly before his death he had been appointed chief research officer for the Associated Sugar Companies of the Island and editor of a new Journal, *Sugar Technology*.

Ladell was elected a fellow of the Chemical Society in 1907, of the Institute of Chemistry in 1911 and of the Royal Entomological Society in 1929. He was very modest in character and a pleasant and enthusiastic colleague; he is survived by his wife and three children.

C. B. Williams.

Flight-Lieut. A. N. David

Flight-Lieut. David, who died recently on service at the age of fifty-three, had been associated with the Forest Products Research Laboratory at Princes Risborough since its earliest days in 1922, when he joined the Department of Scientific and Industrial Research after his retirement from the Indian Forest Service.

After being educated at Aldenham and Oxford, David joined the Indian Forest Service in 1911, and between 1916 and 1919 saw service as a pilot in the Royal Flying Corps. At the outbreak of war in 1939 he at once rejoined the R.A.F.V.R., receiving a mention in dispatches shortly before his death.

During his connexion with the Forest Products Research Laboratory, his work was mainly concerned with the collection of home-grown timber for the various investigations, and the related information on the field conditions of its growth. His cheerful, hard-working personality secured the ready collaboration of the woodland owners, without which it would have been very difficult to obtain suitable material. The collection of field information needed much painstaking work in all sorts of weather; indeed bad weather seemed to dog his expeditions, but never stopped him. His contribution to the work of the Laboratory was most useful, though attracting little attention to itself.

Sir Charles Hyde, Bt.

We regret to record the death at the age of sixty-six of Sir Charles Hyde, proprietor of the *Birmingham Post* and its associated papers. He was, perhaps, relatively little known outside Birmingham except in newspaper circles and on the racecourse, for he shunned publicity. In Birmingham he was known as a most generous philanthropist. Born at Worcester, the son of a surgeon, he was educated at Clifton and Exeter College, Oxford. At the age of twenty-one he entered the newspaper world at the invitation of his uncle, John Feeney, then proprietor of the *Birmingham Post and Mail*; on the death of his uncle he became, in 1913, the proprietor of the *Birmingham Post*, *Birmingham Mail* and *Birmingham Weekly Post*. To the University of Birmingham Sir Charles gave freely, contributing £10,000 to the appeal fund in 1920. He also bought and equipped a large house in Edgbaston as a hostel for men undergraduates, now known as Chancellor's Hall. In 1925 he gave a further £100,000, part of which was to be devoted to the building of the Students' Union, a fine building which has been of supreme importance in the social life of undergraduates. He also gave £10,000 for a Joseph Chamberlain Memorial Museum in the University Medical School.

Sir Charles was a munificent supporter of Birmingham hospitals, the Children's Hospital in particular. He was chairman of Queen's Hospital and from

1919 until 1926 was chairman of the War Pensions Hospital Committee.

Archæology, too, benefited by his generosity, for he financed the excavations at Viroconium, near Wroxeter, of which the results have lately been published. Farther afield his help enabled the University of Belgrade to resume excavations on the prehistoric site of Vincha. He also bore the cost of British Museum excavations at Nineveh and assisted an expedition working on the Necropolis at Vounous Bellapais in Cyprus. His name will long be remembered with gratitude. G. A. SHAKESPEAR.

WE regret to announce the following deaths:

Dr. E. J. Allen, C.B.E., F.R.S., secretary to the Marine Biological Association of the United Kingdom and director of the Plymouth Laboratory from 1895 until 1936, on December 7, aged seventy-six.

Prof. R. A. Gortner, professor of biochemistry in the University of Minnesota, on September 30, aged fifty-seven.

Prof. T. M. Putnam, professor of mathematics in the University of California, on September 22, aged sixty-seven.

NEWS and VIEWS

Reconstruction in Great Britain: The People

THE widespread interest in the problems of post-war reconstruction and planning was reflected in the House of Commons debate on December 1 and 2 on an amendment to the Address. The debate was characterized by notable speeches from Mr. Greenwood, Sir William Jowitt and Mr. Anthony Eden. Sir William Jowitt gave a comprehensive but general account of the Government's policy. Sketching the post-war position and stressing the importance of international co-operation in a deliberate effort to improve the standard of living throughout the world in order that consumers abroad may be able to buy that which we produce, he said that he believes we must become as a nation more scientifically minded, prepared, whatever industrial system we adopt, to use scientific methods and to aim at the greatest efficiency in those methods. The Ministerial Committee over which he presides is, he said, trying to work out practical schemes of reconstruction to which effect could be given in the first few years after the War, and presupposing in its plans a social and economic structure designed to secure equality of opportunity and service among all classes of the community. The Ministerial Committee is assisted by an external and an internal committee of highly placed and experienced Civil Servants. Demobilization plans are being prepared; these include the question of education and training for those whose educational careers have been interrupted by the War. With regard to getting the workers back into industry, the Government considers that each industry should be surveyed separately, because the structure of industry will not fit into a common mould. The points of contact between Government and industry require strengthening, and Sir William said that capital must be ready to seek new opportunities and labour must be prepared to be more fluid.

The Land

Fully accepting the views of the Scott and the Uthwatt Committees as to the need for correlating policy, the Government has decided, Sir William said, in view of the importance of maintaining Parliamentary responsibility, to ask Parliament to constitute a separate Ministry of Town and Country Planning. This Minister will be a member of the Ministerial Committee already supervising reconstruction policy, and there are also important functions for which a permanent commission, acting under the Minister of Town and Country Planning, will be the most appropriate body. The Government has reached no decision as to the acquisition by the State of development rights in all undeveloped land or on a levy on increases in annual site values, but it is proposing in forthcoming legislation to confer wide and simple powers on local authorities for the compulsory acquisition of land. In regard to food, Sir William said that the wise developments of the last few years should not be abandoned after the War. Close attention is being given to the formulation of a permanent post-war agricultural policy, on which the Dominions will be consulted. A really vigorous forestry policy will be adopted after the War, for which the Forestry Commission has been instructed to formulate a programme. Sir William also referred to the organization of electricity supply on the most efficient basis, to the close review of water supply, and finally to the place of education in reconstruction.

International Aspects

Sir William Jowitt's references to the importance of international co-operation and to collaboration with the International Labour Office were amplified in the speech with which Mr. Eden replied to the second day's debate. Reiterating our determination to assist in the immediate relief of post-war Europe, Mr. Eden pointed out that the manner in which, and the extent to which, we succeed or fail in co-operating with our Allies now will largely determine the course of post-war foreign policy. Whether we are able to maintain peace or not afterwards will depend on whether we can carry through the co-operation we have now established with the United States of America, with Soviet Russia and with China. The first need of Europe will be to build up an enduring system of defence against the possibility of renewed German aggression. He hoped that we are prepared to make our contribution to take our part because we understand that peace and security in Europe are part of our own peace and security.

Welcoming a recent speech of Mr. Sumner Welles indicating American readiness to accept world-wide responsibility for maintaining peace, and recognizing the value of the International Labour Organisation as possibly the main instrument for giving effect to Article 5 of the Atlantic Charter, Mr. Eden pointed out that for any international organization to have a chance to achieve its purpose it must be fully representative of the Powers that mean to keep the peace. Second, the Powers themselves must have the unity and the determination to arrive at agreed and positive decisions; and third, they must have the force behind them to give effect to their decisions. Mr. Eden believes that out of this organization of the United

Nations, based in the first instance on understanding between Great Britain, the United States and the U.S.S.R., a great opportunity has opened, and although the task will be heavy it can be achieved if we do not forget our lessons, and make co-operation in peace as true and effective as in the years of war.

Colonial Policy

Viscount Cranborne, until recently Secretary of State for the Colonies, replied on behalf of the Government in a debate in the House of Lords on December 3 on Colonial affairs. The keynote of his speech was the diversity of the Colonial territories. He remarked that ever since the fall of Malaya there has been a stream of criticism against the administration of the Colonies. That disaster was due, according to some, to the fact that the local peoples had not been sufficiently associated with the government of their country. This explanation, however, cannot apply to Siam, an independent State, or to the excellent administrative system of the Dutch East Indies or of the Philippines. British policy gave Malaya a long period of internal peace, justice and prosperity. The proposal for a Colonial charter presupposes a uniformity which is unattainable and probably undesirable in the British Empire. The Empire consists of a diversity of countries and peoples in all stages of development, and its administration is characterized by great variety and flexibility. There is no cut and dried pattern ; local systems have been adapted and adopted, and there has been gradual evolution in each territory of a form of government which seems best suited to promote the moral and material welfare of the people, with the ultimate aim of self-government.

A fundamental step in advancing to self-government is the provision of education. Surveying the position, Lord Cranborne said that, in the field of mass education, we have to meet first widespread illiteracy. Programmes for adult and community education are being prepared. Elementary education is spreading in Nigeria, the Gold Coast, Uganda, Mauritius and the West Indies, where Sir Frank Stockdale, comptroller for development and welfare, has been working for two years. Higher education is being developed at Achimota in West Africa, and at Makerere in East Africa ; in Ceylon, the university college has been raised to the status of a university ; in West Africa there is a scheme for an institute of arts, crafts and social sciences. Further, much consideration is being given to the education of women and girls. Medical schools are working in East and West Africa, in Ceylon, Malta and Fiji, and important investigations are being carried out by British organizations and by the Rockefeller Foundation. Social security rests, so far as the Colonial Empire is concerned, on economic security, and this in turn on agriculture ; steps for the production of food for local use have been speeded up, and mixed farming has been promoted. Labour conditions have been improved, and Lord Cranborne referred to the Exchequer grant of £5,000,000 a year under the Colonial Development and Welfare Act for approved schemes advanced by Colonial Governments.

A Survey of World Resources

In a report on "The Problem of Raw Materials" prepared by Prof. I. Högbom, of Stockholm, and issued by the League of Nations in 1937, there is a striking graph showing the world production of the principal minerals and metals during the period 1860–1937. Sir Harold Hartley uses this graph as the text of an article, published in *The Times* of November 27, on the need for a survey of world resources. The graph is plotted on a logarithmic scale and demonstrates that production of aluminium, tin, copper, phosphates, petroleum, pig iron, coal and lignite had a steady rate of growth until 1914. Then the general rate decreases sharply, to be followed by violent oscillations during the past twenty-five years. The end of the period of steady increase marked the end of territorial expansion and exploitation, accompanied by failure to realize that world conditions had changed, and that a planned economy was required. Such a plan is implicit in the orderly economic collaboration of the United Nations envisaged in the Atlantic Charter. The goal is "greater stability of world conditions and increased well-being based on the better use of world resources, full employment and the development of backward areas". The foundation of any scheme directed towards this end is a world survey of production and consumption.

Sir Harold points out that the data for the pre-war years are mainly available, though they need bringing together, and the Allied Bureau under Sir Frederick Leith-Ross is dealing with the immediate post-war period. The preparation of estimates for a more stable form of society to succeed this period is a more difficult matter, in view of the fluctuations of the past twenty years. Such long-range estimates must be 'moving targets' subject to such factors as population trends, knowledge of basic needs and the development of backward countries. Estimates of consumption must precede estimates of production, to be followed by surveys of distribution. The data for these estimates, some of them already available through the activities of individual countries and industries, or committees set up by the United Nations, are at present unco-ordinated, with unknown gaps, and, in Sir Harold Hartley's opinion, a United Nations Economic Bureau should be appointed to deal with the matter.

Temperature of the Atmosphere

A further colloquium in the series arranged by the Manchester University Branch of the Association of Scientific Workers was addressed by Dr. T. G. Cowling on December 2, the title being "The Temperature of the Atmosphere". Dr. Cowling began by describing how the temperature of the lower part of the atmosphere is determined by radiation, convection, and advection (horizontal currents of air and water). The distribution of temperature over the earth's surface varies with the season, and in consequence sudden large fluctuations in temperature due to the passage of air masses are in the British Isles more probable during winter than summer. Turning to the variation of temperature with altitude, Dr. Cowling suggested a possible explanation for the fact that the temperature ceases to decrease at a height known as the tropopause. According to this theory, solar energy is absorbed by ozone in the stratosphere, and in the absence of any gas with strong emission bands in the infra-red, the temperature is increased. Water vapour has broad intense bands in the infra-red, and when it is present tends to keep the temperature low. In considering variations of the temperature in the stratosphere with season and latitude, account must be taken of any variations of the concentrations of gases such as ozone and water vapour, as well as of the intensities of the radiations coming from the sun and earth. During the discussion which followed, Dr. L. Jánossy pointed out that the tropopause falls rapidly at the same latitude that shows a marked increase in cosmic ray intensity. Cosmic rays might conceivably produce some ozone, and so account for the higher temperatures over the poles.

Recent Earthquakes

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the epicentres of two recent earthquakes. The first was on September 26, 1942, and took place at approximately 4h. 00·3m. U.T. It had an epicentre near lat. 12·8° N., long. 87·5° W., which is in the region south of the Golfo de Fonseca in Nicaragua in Central America. The second occurred on October 21, 1942, at about 16h. 22m. 15s. U.T. and had an epicentre near lat. 33·1° N., long. 116·0° W., which is to the west-north-west of Imperial in Southern California.

That the earth blocks, the movement of which caused the very severe earthquake of December 27, 1939 in Anatolia, have not yet attained their position of equilibrium is shown by the earthquakes and tremors which still occur in the district. The latest strong shock of this series occurred about 10 p.m. local time on December 3. At Ciorum, sixty miles from Ankara, the tremors lasted 25 seconds according to human perception. Four people are reported to have lost their lives and nine were injured in Central Anatolia.

Sir William Power, F.R.S. (1842-1916)

SIR WILLIAM HENRY POWER, an eminent Victorian epidemiologist, was born at Bosworth on December 15, 1842, the son of a medical practitioner. He was educated at University College, London, and qualified in 1864. After serving as resident medical officer at the Victoria Hospital for Diseases of the Chest, where he gained much valuable information in connexion with tuberculosis, he was appointed in 1871 temporary medical inspector in the Local Government Board, where he made a special study of the small-pox epidemics in London of 1871–72 and 1881 and upheld the theory of the aerial convection of disease, particularly in relation to the Western Hospital, then known as the Fulham Small-Pox Hospital. The publication of his "Statistics of Small-pox Incidence in the Registration Districts of London relating to the Operation of Small-pox Hospitals in the Metropolis" led to the permanent removal of all small-pox cases occurring in London to extra-metropolitan hospitals, a practice which still holds good. His other publications included reports on epidemics of diphtheria in Warwickshire and Essex, an outbreak of scarlet fever in certain districts of London believed to be due to milk, and lead poisoning by public water supplies. In 1871 he was appointed assistant medical officer in the Local Government Board, and in 1889 succeeded Sir Richard Thorne Thorne as senior medical officer, when he did valuable work in connexion with the Food and Drugs Acts and the Royal Commission on Tuberculosis. In 1895 he was elected a fellow of the Royal Society. He was also awarded the Jenner Medal of the Epidemiological Society of London, the Bissett-Hawkins Medal of the Royal College of Physicians and the Stewart Prize of the British Medical Association. He died on July 28, 1916.

Marius Sophia Lie (1842–1899)

ON December 17 occurs the centenary of the birth of the distinguished Norwegian mathematician Marius Sophia Lie, who was born at Nordfjordeif, near Bergen. Educated at the University of Christiania (Oslo), he took his doctorate in 1868 and, after gaining a travelling scholarship, visited France and Germany, making the acquaintance of Klein, Darboux and Jordan. In 1872 a special chair of mathematics was created for him at Christiania, but fourteen years later he returned to Germany to succeed Klein at Leipzig. He returned to the Norwegian capital in 1898, and died there on February 18, 1899. Lie was recognized as one of the most original and independent workers in pure mathematics; he was elected a foreign member of the Royal Society, and the Cambridge Philosophical Society and the London Mathematical Society added his name to their lists of honorary members. Referring to his death, Larmor said, at the meeting of the British Association in 1900, "We have lost one of the greatest constructive mathematicians of this century, who has in various directions fundamentally expanded the methods and conceptions of analysis by reverting to the fountain of direct geometrical intuition".

Admiralty Appointments

THE appointment is announced of Commander C. F. Goodeve, F.R.S., R.N.V.R., reader in physical chemistry at University College, University of London, to the post of assistant controller (research and development) in the Admiralty. Commander Goodeve will be responsible for the co-ordination of research and development in the departments of the Controller of the Navy, and for ensuring that scientific opinion is adequately represented in those Departments and that due weight is given to it.

Sir Stanley V. Goodall, director of naval construction, has been given the additional appointment of assistant controller for warship production. He will remain the principal technical adviser to the Board of Admiralty on the design of warships and other vessels for the Royal Navy. In his capacity as assistant controller for warship production he will be responsible under the Controller of the Navy for the production of warships and their completion with all appropriate supplies, and for the necessary co-ordination to achieve the fastest possible results with the greatest economy of effort.

Announcements

SIR JOHN RUSSELL retires on September 30, 1943, under the age limit, from the directorship of the Rothamsted Experimental Station. Sir John Russell succeeded Sir Daniel Hall in 1912 and during his thirty-one years as director the Station, the oldest agricultural institute in the world, has shown a remarkable expansion of its research activities and of its authority in agriculture.

MR. HARRY R. RICARDO, who is well known for his outstanding work in connexion with internal combustion engines, has been elected an honorary member of the American Society of Mechanical Engineers, New York.

IN recognition of his distinguished services as rector of the Imperial College of Science and Technology during 1929–42, Sir Henry Tizard, president of Magdalen College, Oxford, has been elected a fellow of the Imperial College.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Production of Penicillin

PENICILLIN, the metabolic product of *Penicillium notatum*, discovered by Fleming in 1929, has been shown to be a chemotherapeutic agent of great importance. The exceedingly high bacteriostatic potency of this substance, together with its low toxicity to tissue cells, are such that penicillin has been described as "the most powerful antibacterial agent with predominantly bacteriostatic action so far known"[1], and its value in human therapy has already been demonstrated[2].

It is, therefore, unfortunate that the production of crude penicillin is a somewhat lengthy process in which the yield of this valuable but unstable product is small[1,2]. Further, the process involves the culturing of the mould in large volumes of fluid medium in culture vessels in which the depth of medium is small. The incubation space therefore required is so great that the facilities of even the larger laboratories are inadequate for the production of penicillin in quantity sufficient for therapeutic use, or for the further work required in the elucidation of its chemical structure. By the modified method of production outlined below, the bacteriostatic metabolic product of *P. notatum* is produced in 5–6 days in yield comparable to that obtained in 10–11 days by the method as previously described[1,2]. This means that for a given incubation space the *output* of the crude active substance may be considerably increased (for example, doubled) and, in addition, the modified method has other advantages.

Attempts were made to increase the yield of penicillin by adding to the medium (as used by Florey *et al.*[2]) substances which might serve as growth factors. In this connexion it was thought that the culture fluid itself might contain such substances. Therefore, small quantities (0·1–10 c.c.) of fluid from an 11-day culture of a previous batch were added to culture vessels containing 200 c.c. of medium, after which the bottles were seeded with *P. notatum* and then incubated at 24° C. along with cultures to which no culture fluid was added. These experiments were strikingly successful and the course of the metabolism was profoundly altered as judged by the following criteria: growth and sporulation of the mould, pigmentation of the culture fluid, *p*H changes and appearance of coloured droplets on the surface of the mycelium were all considerably accelerated as compared with untreated cultures (controls), and the rate of production of the antibacterial substance after 4–5 days' incubation, as judged by the ring assay test described by Florey *et al.*[2], was increased considerably. However, these results were not maintained during further incubation, the assay tests then indicating a considerable diminution in the amount of antibacterial substance present in the culture fluid. Observations of the changes in the *p*H of the culture fluid suggested that the antibacterial substance was being destroyed by the excessive amount of acids produced under the changed experimental conditions.

Accordingly, similar experiments were carried out in a medium adequately buffered by the addition of a strong solution of mixed phosphate buffers, the proportion of the mono- and dihydrogen phosphates being determined after consideration of the *p*H ranges most favourable for the stability and production of penicillin. The results of these experiments were entirely satisfactory, and the amount of antibacterial substance produced in 5–6 days (so far as could be judged by ring assay tests on the *diluted* culture fluid, and by the serial dilution method as used by Fleming[3]) was at least equal to that produced in the control experiments in 10–11 days, that is, in cultures seeded from the same suspension of the mould and incubated along with the test cultures. Assay tests on the culture fluid after several days' more incubation (in addition to the 5 days) showed no diminution in the amount of active substance present, and work is in progress in order to ascertain if the yield of the active substance *per given volume of culture fluid* may be increased, that is, as compared with the yields obtained in 5–6 days by the modified method or in 10–11 days by the older method.

Pigment production during the shorter incubation period of the modified method was less than in the 10–11 day period of the unmodified method, and this is an advantage of importance, since the isolation and purification of the active substance will therefore be facilitated.

In preliminary experiments, buffering of the medium as in the successful experiments outlined above, but without the addition of the culture fluid, appeared to alter the metabolism of the mould as in the experiments in which both culture fluid *and* buffer were added. Further work is in progress in order to ascertain whether the addition of culture fluid is necessary.

At present only small quantities of the crude antibacterial substance have been prepared by the modified method. The substance, however, was found to be extractable at *p*H 2 by amyl acetate and from the amyl acetate solution the active substance was re-extracted at *p*H 6·4 with aqueous barium hydroxide. There is therefore no reason to doubt that the bacteriostatic metabolic product of *P. notatum* produced was penicillin, although rigid proof cannot be brought forward until the active substance has been isolated in a more highly purified form.

S. W. CHALLINOR.

Bacteriology Department,
University of Edinburgh.
Nov. 30.

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[1] Abraham and Chain, *Brit. J. Exp. Path.*, **23**, 103 (1942).

[2] Abraham, Chain, Fletcher, Florey, Gardner, Heatley and Jennings, *Lancet*, **241**, 177 (1941).

[3] Fleming, A., *Brit. J. Exp. Path.*, **10**, 226 (1929).

Experimental Production of a Pouch in the Male of *Trichosurus vulpecula*

THE female of *Trichosurus vulpecula*, the common Australian phalanger or possum, has a well-developed pouch, while the male possesses in the corresponding region a large pendulous scrotum. On injecting large doses of œstrogen into males of varying ages there appeared at the sides of the scrotum skin folds which strongly suggested the formation of a rudimentary pouch, particularly in immature animals[1].

To obtain more definite information as regards the true nature of these folds the small scrotal sac of three pouch young of three to four months of age was amputated with or without the testes.

The best result was obtained from a pouch young of three months of age where the testes occupied a position external to the body wall but had not actually entered the scrotal sac. The scrotum, measuring about 0·2 cm. in length, was amputated while the testes were left behind. A fortnight after this operation 40 I.U. of gonadotropin obtained from human pregnancy urine was injected intramuscularly, and a month after the operation 0·1 mgm. of œstradiol dipropionate was administered. Second and third injection of 0·2 mgm. of œstradiol dipropionate was given respectively one week and three weeks later.

Due to the amputation of the scrotum the testes remained separated. However, already after the first injection of œstradiol dipropionate a V-shaped ridge of raised tissue containing the separated testes as well as the remaining scrotal elements became very prominent. After the second injection of œstradiol dipropionate definite infolding of the abdominal skin along this ridge became visible and a recess was formed beneath it. A few days later a typical pouch had formed, though its swollen and puckered lips were still diverging cephalad at an angle of about 45°. After the third injection of œstradiol dipropionate the animal was capable of closing the lips almost completely, thus presenting a fully developed pouch similar in size and shape to that found in females of about equal age treated with œstrogens. The small and elongated testes became situated in the lips of the pouch and were not discernible on superficial examination.

In the case of the other two pouch young of about four months of age the scrotum with the now descended testes was amputated. Prior and immediately after the operation these animals were also given chorionic gonadotropin. A few weeks after the removal of scrotum and testes œstradiol dipropionate was administered in amounts of 0·1–0·2 mgm. In both these animals a typical pouch was also formed but the results were less perfect than in the first experiment because in one instance no apposition of the lips could be obtained. In the other animal there was an infolding of the skin along the almost closed lips except where they joined at the caudal end of the experimentally produced pouch. These imperfections were probably due to the fact that in the more extensive operation of removing a larger scrotum containing the testes, more of the elements required for the formation of the pouch were removed. After establishing a pouch all three animals lived for about another month and then died, apparently from the toxic effect of the administered œstrogen.

In contrast to the finding of Burns[3], that both scrotum and pouch of the polyprotodont marsupial *Didelphys virginiana* do not react to hormone treatment, the experiments now described in conjunction with others[1,2] on the diprotodont, *Trichosurus vulpecula*, indicate a far-reaching hormonal control over these organs. They appear to be definitely homologous, the pouch being an invagination and the scrotum an extrusion of the same area of abdominal skin which is characterized by the presence of only a little muscle.

A. BOLLIGER.

Gordon Craig Research Laboratory,
Department of Surgery,
University of Sydney.
Oct. 7.

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[1] Bolliger, A., and Carrodus, A., *Australian and New Zealand J. Surgery*, 9, 155 (1939).

[2] Bolliger, A., and Carrodus, A., *J. Roy. Soc. N.S.W.*, 73, 218 (1940).

[3] Burns, R., *J. Morph.*, 65, 79 (1939).

Onions and Vernalization

IN connexion with work on the induction of flowering, an attempt was made to vernalize onion. It is known that autumn-sown onions occasionally become thick-necked in the following summer. In February of this year, onion seed of the varieties James Long Keeping and Ailsa Craig was germinated at 23° C. Those seeds in which the radicles were just emerging (one day after soaking) were subjected to a temperature of 2° C. for three weeks and seven-eight weeks and were planted out in seed trays; they were kept in a greenhouse until mid-March and the end of April respectively and all transplanted in the open air on May 7, together with untreated controls germinated on February 25, and also on April 1 in the case of Ailsa Craig.

In September last flowers were seen on some of the Ailsa Craig plants which had been vernalized for three weeks, and by October 21, 10 of the 37 plants bore flowers. In no other treatment were flower-buds produced, though in all, thick-necked bulbs preponderated except in James Long Keeping unvernalized. No flowers opened, though the bracts of three inflorescences have parted, and all inflorescences are in healthy condition at the present time (November 24). JEAN MARGARET FRY.

Department of Botany,
University,
Bristol 8.

A Red Colouring Matter from the Green Leaves of Spinach Beet

THE production of a red colouring matter from an extract of the green leaves of spinach beet, reported by Marsden[1], is capable of explanation on the basis of a well-known redoxase-chromogen relationship.

The aqueous extract of the green leaves may be assumed to contain a colourless or lightly-coloured chromogen. The aqueous extract of raw potato has been tested by the benzidene, α-naphthol and guaiacum tests and found to contain oxidase, peroxidase and catalase. The expressed cell-sap of spinach-beet leaves contained only peroxidase and catalase.

When these two extracts are mixed the chromogen reacts with the oxidase with the production of the brownish-red pigment. The probability that the action is of an oxidizing character is increased by the fact that shaking speeds the production of colour. Soaking leaf-tissue in aqueous hydrogen peroxide for an hour imparts a brown colour to the sap of epidermal cells. The presence of a chromogen would seem to be confirmed.

The brownish-red colour suggests an oxidized anthocyanin as reported by Jones[2]. In its reactions with caustic soda and hydrochloric acid, and ferric chloride solution, it agrees with the pigment from beetroot. But with sodium carbonate solution the spinach-beet pigment gives a bright yellow solution while that from beetroot gives a violet solution. Neither pigment is appreciably extracted from acidified aqueous solution by amyl alcohol or a 1 : 5 mixture of cyclohexanol and toluene. Both pigments slowly fade on heating.

H. G. BAKER.

114 Evelyn Crescent,
Sunbury-on-Thames,
Middlesex. Nov. 16.

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[1] Marsden, R. J. B., NATURE, 150, 580 (1942).

[2] Jones, W. N., *Proc. Roy. Soc.*, B, 86, 318 (1913).

Optical Reflections from Coal

THE classification of the petrological constituents of coals developed in Great Britain by Dr. Marie C. Stopes and published in a revised version in 1935[1] has been widely adopted as a basis for further research in many directions. Much more attention appears, however, to have been given to petrological and chemical than to physical properties. Many workers give density determinations and C. Mahadevan has made an X-ray diffraction study of coals[2]. In general, measurements for the coal properties selected have cut across the Stopes classification when they have been determined for vitrain, clarain, durain and fusain. Typical results taken from Hoffmann's paper[3] are given in Table 1 showing the maximum variations in samples taken from different seams in the same coalfield, and the overlap between the constituents.

TABLE 1. SAMPLES FROM TWELVE MINES IN SAAR COALFIELD SHOWING MAXIMUM VARIATIONS.

Constituent	Ash	Volatile matter	Specific gravity
Vitrain	0·4– 2·2	27–36	1·2–1·9
Fusain	1·0– 8·0	9–18	1·4–1·7
Clarain	0·7–11·0	32–47	1·2–1·4
Durain	0·3–45·0	29–62	1·2–1·7

From the wide range of variations, it would appear that if an attempt were made to select a specimen of one of the constituents on the basis of the quantitative data alone, a mistake might easily be made. Since so much work has been done by so many workers on the subject, some property or properties of coal must have been used first to select, without doubt, from a lump of coal a specimen of, say, vitrain. Dr. Stopes's reference to "such ingredients, in hand specimens, as are visibly different from each other", suggests the relevance of optical properties. (Elastic properties are also involved in the detailed description, given in the large table "A Classification of Coal Ingredients", accompanying Dr. Stopes's paper.)

An attempt has therefore been made to study quantitatively the optical properties of coals. Specimens were prepared by cutting, grinding and polishing plane surfaces on the samples of the petrological constituents (with the exception of fusain). The specimens were mounted, in turn, on the table of a spectrometer in which the telescope had been replaced by a photo-electric cell unit for measuring light intensities. With the collimator fixed, the coal surface was mounted in a vertical plane reflecting the incident parallel beam of light. At various fixed angles of incidence, the intensity of the light reflected in the region of the specular angle was measured. Typical results are shown in Fig. 1 for the region around a specular angle of 60°. The spreading of the reflected beam is greatest for fusain, least for vitrain, with durain lying between the two. Data are not given for clarain, which in the new Stopes classification is regarded as vitrain mixed with some of the microscopic constituents of durain and fusain. Fig. 2 is a typical curve for the variation of maximum intensity of reflection with angle of incidence, showing, as grazing incidence is approached, the rapid increase in intensity of reflection characteristic of dielectrics.

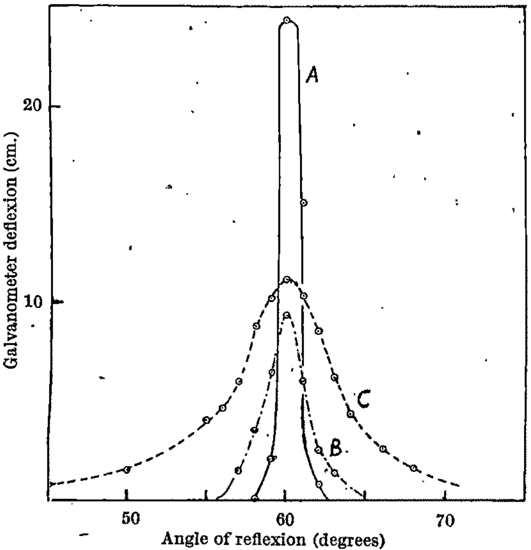

Fig. 1. VARIATION OF REFLECTED INTENSITY AROUND THE SPECULAR ANGLE WHEN THE ANGLE OF INCIDENCE IS 6°. *A*, VITRAIN ; *B*, DURAIN ; *C*, FUSAIN.

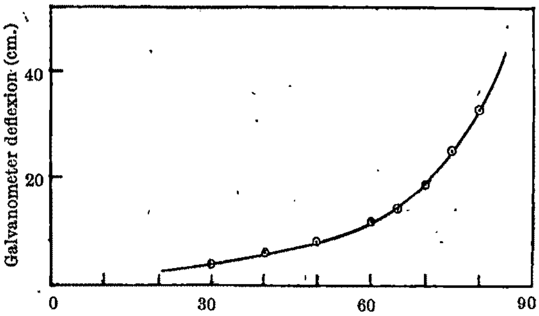

Fig. 2. VARIATION OF MAXIMUM INTENSITY OF REFLEXION WITH ANGLE OF INCIDENCE.

The method was then applied to typical specimens of some of the petrological constituents from different types of coals and the results are shown in Table 2.

TABLE 2. SPECULAR REFLECTION FOR POLISHED COAL SURFACES AT 60° ANGLE OF INCIDENCE AND REFLECTION.

Sample and description		Galvanometer deflection (proportional to intensity)	Percentage reflection (approx.)
	(Incident intensity approximately 150 cm.)		
DURAIN	Warwickshire	3·5 cm.	2·0
	Northumberland	5·2 cm.	3·5
CANNEL	Derby	7·6 cm.	5·0
VITRAIN	Freeburning coal, Yorks.	8·6 cm.	5·7
	Coking coal, Durham	9·7 cm.	6·5
	Freeburning coal, North'd	10·7 cm.	7·1
	Bright coal, Derby	10·9 cm.	7·3
	Bright coal, Warwick	10·9 cm.	7·3
	Anthracite, S. Wales 1....	11·1 cm.	7·4
	Anthracite, S. Wales 2....	14·7 cm.	9·8
	Anthracite, Durham	23·6 cm.	15·7

It would appear that the petrological constituents fall into groups ; for example, durain 2–4 or vitrain 5·7–15·7, giving a quantitative classification corresponding with that of Stopes, allowing individual variation, without the overlapping of the groups common to quantitative determinations of other properties. Although the numerical values are altered by the method of treatment of the surfaces, the distinctions remain if the different surfaces are given comparable treatment.

Thanks are due to Dr. D. H. Bangham, principal scientific officer of the British Coal Utilization Research Association, for his kindness in providing free access to the Association's collection of samples.

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[1] *Fuel*, **14**, 4–13 (1935).

[2] *Fuel*, **14**, 231–241 (1935).

[3] *Fuel*, **8**, 525 (1929).

SCIENTIFIC FILMS IN TEACHING PHYSICS

A DISCUSSION on "Scientific Films and their Use in the Teaching of Physics" was held at a meeting of the Physical Society, on November 20. It was opened by Mr. W. Ashhurst, who pointed out that more lecturers and teachers would use films if they knew more about the technique of their use and could obtain sufficient suitable ones.

Undoubtedly there will be a great increase in the number of projectors in use after the War. The War has seen a wide increase of use of the film as a training and propaganda medium. The fighting Services and Home Guard are now using projectors. The Ministry of Information has equipped and trained a corps of projectionists; potentially, this service, now devoted to propaganda, could be a magnificent adjunct to educational media in peacetime. We may well be at the beginning of a revolution in teaching and demonstration techniques. It is urgent that science teachers should have clear aims and a clear attitude to this medium. The film should be treated as an essential part of public education and public service, as are laboratories, gymnasia and clinics. The few projectors in use in England can be contrasted with the large numbers in use in other countries.

Mr. Ashhurst then referred to an article by Mr. Oliver Bell, director of the British Film Institute, in the *Documentary News Letter*, in which it is suggested that the Government should be prepared to spend £1,500,000 in ten years on visual education.

On the production side, Great Britain has created some good scientific films, but so also have other countries, and "Mouvements Vibratoires" is an example of French lucidity and elegance in the making of a science teaching film.

The cinema has much power in the class room. It can enliven the teaching of pure science and can also point dramatically and vividly to its applications. It appeals in a familiar way, and, with suitable guidance by the teacher, important information can be impressed upon the memory. The film brings the outside world into the class-room. In science teaching, the application of fundamental principles in industry can be presented in a manner from which, very often, more can be learned than by actually taking a tour around a workshop or industrial plant.

The film has obvious advantages over the blackboard for illustrating a moving mechanism. Animated diagrams can be exceedingly clear. Quickly moving objects can be photographed using slow-motion photography, which is useful in engineering, and peeded-up photography is largely responsible for the uccess of plant-life films. Both these techniques have obvious applications for the practical exposition of physics problems.

The old controversy of the relative merits of sound and silent films may be resolved by stating that each has its own particular uses. Undoubtedly, the majority of science teachers prefer to supply the commentary. Each topic should be treated in the manner more suited to it. Obviously, a film illusrating a demonstration of a 'sound' experiment should be a 'sound' film, and, similarly, a film about olour should be in colour. It thus follows that most expositional films should be silent, whereas application or background films, sound. Generally speaking, a film which is to be run straight through should use sound, for then the commentary would be carefully worded and synchronized; in contrast, a teacher's extempore commentary would be very inferior.

A film should not be used in place of a demonstration.

The diagrammatical film can be drawn perfectly and 'animated'. A special type is the cycle or loop film. Loop films are used in the representation of cyclic actions. Their unique value is in memorizing cycles and presenting physical and mathematical rhythmic phenomena in a vivid way.

There are at least four ways of using films in the class room. (1) As an illustration comparable in its use with a lantern slide. An example of this type, which should necessarily be short, is the cycle film. It is a brief demonstration introduced as incidental to the theoretical lesson. (2) As a basis for a film lesson. A special lesson is given based on the particular film. It is necessary for the teacher to know the film well and build around it. Different teachers have different methods, but the value of the film is lost if it is not discussed fully afterwards and the important points pressed home. Many teachers commence the lesson by a showing, then, by questions, analyse its content and deal with the theory involved, finally concluding the lesson by a second showing. Experience shows that the attention should be directed before, or during the showing, to important things. There is always the tendency for the attention to wander on to something of lesser importance. (3) For revision purposes. There is a great possibility for such films. A good ten-minute film can revise effectively the work of several lessons. (4) To show the application of fundamental principles and possibly their social implications. Here, background films are employed, and with their aid the class is taken from the class room to the factory or industrial plant. The scope of such films is unlimited and their value obvious. It is through the social and industrial documentary that science joins hands both with the rest of the curriculum and the outside world.

The opening remarks were followed by a showing of various films. These were selected to illustrate the different types, namely, the illustrative film, the film for the film lesson and the background film.

In the discussion which followed, opinions were stated by members, some experienced and others inexperienced, in film use. Many physicists are prejudiced against the use of films, as physics deals with real things, not pictures. Moving diagrams may be annoying, but perhaps, as the pupil becomes familiar with such representations, he may not be so affected. The film may offer a solution in special cases where laboratory and demonstration facilities are not good; for example, in workshop schools far removed from a technical school. On no account should irrelevant matter be included: the teaching film should be full of substance and devoid of theatrical packing.

There are clearly great possibilities for films depicting the lives and work of the great men of science. The few such films already in existence, for example that on the life of Pasteur, are obviously not suitable for use as a whole in schools. Excerpts might perhaps be made, but it would be very much better to prepare films specially for school use, giving particular attention to the limitations imposed by class-room conditions as regards both time and physical difficulties.

ASSOCIATION OF UNIVERSITY PROFESSORS AND LECTURERS OF ALLIED COUNTRIES IN GREAT BRITAIN

As the established bodies for intellectual collaboration were obliged to cease their work owing to the War, universities being in many cases closed down in the occupied countries by the invader, scholars, professors and lecturers from all over the world gradually made their way to England, where they now have their headquarters and are living and working in all parts of Great Britain.

This assemblage seemed to present a unique opportunity for men of mutual interests and intellect to come together and form an Association. A few professors of different nationalities, headed by Prof. Stefan Glaser of Poland, decided to start an Association, the aims of which are the reconstruction of universities in the occupied countries after the War, the development of an academic fraternity between allied university teachers and research workers now in Great Britain, the consideration of all academic problems both during the War and in the post-war period, collaboration with any other bodies which may have similar interests, the examination of problems referred to it by any of the Allied Governments or by any other appropriate official bodies.

The first general meeting was held on May 11, 1942. From the very first there was a great deal of interest and enthusiasm and an organization was formed under the title of "Association of University Professors and Lecturers of Allied Countries in Great Britain". There are at present 225 members and twelve countries are represented, besides India and the British Dominions.

As the whole subject of post-war reconstruction and education is a long and very complex one, it was furthermore decided to get in touch and collaborate with other associations of similar interests. Contacts were made with the British Association for the Advancement of Science, the British Association of University Teachers, and the American University Union. Several neutral countries, which may have representatives as guests, have been approached, and all the vice-chancellors of universities in Great Britain have been informed of the programme of work.

Since the Association has to deal with different domains and subjects, it was decided to form separate sections in order that members should be able to collaborate on subjects of mutual interest. There are at present twelve such sections:

(1) Contact and collaboration with British scholars; organization of lectures of Allied professors in Great Britain (*Provisional chairman*, Prof. P. Vaucher).

(2) Collaboration with other international bodies; international research centre in Great Britain; international review of science and learning (*Provisional chairman*, Prof. J. Timmermans).

(3) Reconstruction of science and learning in the occupied countries (*Provisional chairman*, Prof. S. Glaser).

(4) Re-education of youth after the War and alleviation of moral damage; future collaboration (elaboration of common programmes of teaching, improvement of existing programmes, exchange of students and teachers, acknowledgment of Allied diplomas in Great Britain and so on); elaboration of main principles of the future social order; international university (*Provisional chairman*, Mr. Randall Lane).

(5) Law (*Provisional chairman*, Prof. A. L. Goodhart).

(6) Science (*Provisional chairman*, Prof. A. Photiades).

(7) Economy (*Provisional chairman*, Prof. J. A. Veraart).

(8) Modern humanities (*Provisional chairman*, Prof. L. Genissieux).

(9) History (*Provisional chairman*, Dr. Yuen-li Liang).

(10) Technical science and engineering.

(11) Medicine, as distinct from general science (*Provisional chairman*, Prof. J. Skladal).

(12). Philosophy.

The executive committee consists of sixteen members, namely:

Belgium: Prof. Jean Timmermans; China: Dr. Yuen-li Liang; Czechoslovakia: Prof. Vladimir Klecanda; France: Prof. René Cassin, Prof. Paul Vaucher; Great Britain: Sir Alfred Zimmern, Prof. B. Ifor Evans, Prof. W. Entwistle, Prof. R. Douglas Laurie; Greece: Prof. Alexander Photiades; Netherlands: Prof. J. A. Veraart; Norway: Prof. A. Sommerfelt; Poland: Prof Stefan Glaser, Prof. B. Helczynski; United States of America: Prof. A. L. Goodhart; Yugoslavia H.E. Prof. Milan Grol.

The officers of the Association and of the executive committee are: Prof. Stefan Glaser (president) Prof. Jean Timmermans (vice-president); Prof. B Ifor Evans (secretary-general); Prof. Paul Vaucher (treasurer).

The second general meeting as well as a meeting of all sections will take place on December 16 at the Rembrandt Hotel, Thurloe Place, S.W.7, at 4 p.m Information concerning membership or details regarding the work and aims of the Association can be obtained from the Secretary for the Association, 4 Queen's Gate, London, S.W.7.

A NEW SOCIAL CONTRACT

By D. CARADOG JONES

"Something to Look Forward To"* is the title of an ingenious pamphlet by Lady Rhys Williams in which a new form of social contract is outlined, capable in her view of providing security and a fuller home life for the ordinary men and women of Great Britain "within the framework of our democratic constitution, and without destroying or even greatly altering the present organization of industry, finance, and the machinery of Government" She does not agree with those who maintain tha economic security for the worker is only possible subject to the nationalization of the chief sources of production. If it can be proved that, under private enterprise and the profit motive, the system which has prevailed and made Great Britain relatively rich in the past, it is possible to preserve liberty and to banish want, then it would be unwise, argues Lady Williams, to scrap this old system and substitute a new one which at best is bound to be a gamble. She offers such a proof and supports it with statistics. While it is possible to check her arithmetic—one error may be noted in the total under A(4) on p. 40—the fundamental figures on which her estimates of cost are based are given in the form of averages and it is not clear how these have been determined.

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* Something to Look Forward To: a Suggestion for a New Social Contract. By Lady J. Rhys Williams. Pp. 54. (Cardiff: *Western Mail and Echo*, Ltd., 1942.)

The author believes that, although there would be no intrinsic difficulty in distributing to all men on an equal basis the goods which already exist, the incentive to production would quickly disappear if that were done. Nor would this difficulty be overcome by an extension of national insurance. Already, with our pre-war rates of benefit, many an unskilled labourer with several children could do better on the dole than by a hard week's work for wages. The solution proposed is in effect the free offer of a dole to everybody (though to call it bare maintenance sounds better) irrespective of their income or state of employment. This, it is claimed, would at least have the merit of not placing those who are out of work at an advantage over those who are in work.

Perhaps the term "free offer" is scarcely fair. Those who accept would be expected in return to follow their normal occupation, to register at an employment exchange, and to accept suitable work in their own line. If unemployed beyond, say, twelve months, training for a new trade would be provided or assistance in removal to another part of the country where work might be available. This is the essence of the contract.

The nature of the maintenance scheme is best illustrated by a practical example. Consider the case of a man earning £4 a week, with a wife and two dependent children. This family would get allowances for rent, fuel and light, and food in the form of non-transferable coupons valid only between certain dates, the cash value of the coupons depending on the size and composition of the family. They would be exchangeable into money, either at a bank or at the local office which issued them, by the landlords and retailers to whom they would be paid by the householder. In the particular case chosen the allowance for rent would be 7*s.* a week in respect of the householder and 3*s.* 6*d.* in respect of each dependant, or 17*s.* 6*d.* in all. The corresponding allowance for fuel and light would be 1*s.* 6*d.* a week for the man and 1*s.* 3*d.* for each dependant, or 5*s.* 3*d.* in all; and for food 8*s.* for the man and 7*s.* 3*d.* for each dependant, or 29*s.* 9*d.* in all. In addition the man would get a cash allowance of 3*s.* 6*d.* a week and each dependant would get 2*s.* 6*d.*, making 11*s.* in all. Thus the cash value of the total benefits payable to this household would amount to 63*s.* 6*d.* We must offset against this a flat-rate tax of 7*s.* 6*d.* in the pound, which it is proposed to levy on the first £250 of all incomes, or 30s. in this case. Hence the net weekly gain to the family would be 33*s.* 6*d.*

Certain supplementary benefits are proposed covering health, education, and funeral costs. All these would be a clear addition to wages, military and nurses' pensions, and other forms of retirement pay. But old age and widows' pensions, also benefit under the Health Insurance Acts, would be superseded by the new scheme. Unemployment benefit, on a reduced scale, would still be paid to those out of work through no fault of their own; but unemployment assistance and public assistance, apart from exceptional cases, would cease.

The flat-rate tax mentioned above is estimated to provide roughly four fifths of the money required (£2,070 million) to finance the scheme, the balance to come from savings on existing social service expenditure and economies due to bulk-purchase of foodstuffs, to which are added the benefit of present food subsidies and a grant of some £100 million from the Exchequer.

The idea of providing free State maintenance for the poorest section of the population has attracted many thinkers, if only as a means of tidying our conglomerate social services by a clean sweep. It will be interesting to compare Sir William Beveridge's solution of this problem, not made public at the time of writing, with that of Lady Williams. Before her interesting plan receives serious consideration, no doubt the question will quite reasonably be asked whether it is really necessary. Admitting, as she apparently does, that the machinery of production, if fully utilized and directed to the satisfaction of human needs, is capable of providing "undreamed of prosperity", should not such full utilization provide employment for all, and should not wages, salaries, and profits rise in step with production—without any drastic change in the economic system—granted that enough (but not too much) credit is always made available to circulate the goods? Nevertheless, the proposals contained in the pamphlet provide refreshing food for thought for all who are interested in the major question of the future: the disposal of surplus production.

SHIPBUILDING AND RESEARCH

THE seventeenth report of the Select Committee on National Expenditure, dealing with merchant shipbuilding and repairs, points out that the rate of output of merchant ships has been greatly increased since the beginning of the War. The programme of merchant shipbuilding which was set for 1941 was substantially attained, and in the first six months of 1942 the programme was slightly exceeded. The arrears of repair work have been cleared off, partly as a result of a decline in the amount of repair work, but partly also because of improvements in organization. The output per worker has greatly increased and has probably never been higher. In one region it increased by one half between February 1941 and June 1942, and the evidence is that in spite of American advantages in labour supply and the absence of black-out restrictions, the output per man in tons of steel in the American yards is about half that in the British yards.

In the view of the Admiralty the greatest difficulty is in obtaining sufficient labour, and the Select Committee concurs in pointing out that for a larger shipbuilding programme further measures will be required to provide the necessary labour, by the recruitment and training of new workers, better utilization of the labour force and improving the output of each worker. Riveters present a special difficulty, and the establishment of training schools for riveters in the main shipbuilding areas is recommended under the management either of the Ministry of Labour or of private shipbuilders in their own yards. Inquiry by the Ministry of Labour into the experience gained of the employment of women in other heavy industries, as well as in shipbuilding, so far as it is available, is also recommended, to decide what trades can be carried on by women and und what conditions, and what standards of hea should be required. A larger proportion of women in the age-group 20–30 should be made available for shipbuilding, and once again the importance of welfare work is stressed and the appointment of women welfare supervisors urged.

Personnel management and questions of morale and co-operation recur in this report, as well as of management, and the Committee emphasizes the wisdom of taking all possible steps to put before the workers the full gravity of the shipping position.

It is, however, the section on technique, design and research that is of the greatest interest to scientific workers. Here a careful examination of pre-fabrication of hull portions from the point of view of economy of labour is recommended. Under present conditions, the use of welding beyond a certain point does not appear to effect any saving of time as compared with riveting by skilled squads. Expert opinion inclines to the view that in British yards a combination of the two methods will give the best output. There appears still to be some room for standardization of sections and fittings and the elimination of non-essentials, and the Committee suggests that the British Classification Societies should review their rules to ascertain how far production could be assisted without lowering standards of safety.

It is disappointing to find in this section of the report the opinion that the resources of the William Froude Laboratory have not been fully exploited for war purposes by shipbuilders or by the Admiralty. The Committee therefore recommends that shipbuilders should be instructed to consult the National Physical Laboratory at the appropriate stages in the design of all proposed new types of hull, and that the Admiralty should see that full technical liaison is maintained with the Laboratory. Similarly, commenting on the delays and interruptions in the dissemination of the results of research into the problems of merchant shipbuilding and marine engineering, and the actual decrease in such research by the Institute of Welding, the Iron and Steel Institute, or under the auspices of the three universities possessing chairs of naval architecture, since the War, the report recommends that the Admiralty should establish an organization with the specific responsibility for directing and co-ordinating all development and research in respect of merchant shipbuilding. Coupled with this there is recommended, first, the appointment, in close association with this organization, of a technical intelligence staff, and, secondly, that where several firms are building similar vessels, one of them should act as leader for each part of the complete vessel and machinery, and be responsible for development and improvement in production technique for that part.

Apart from these recommendations to rectify a disturbing lapse of research activities on the part of institutions which might properly have been expected to intensify them, there are other recommendations affecting organization, such as a survey of all yards engaged exclusively on naval work to ascertain whether a small admixture of merchant shipbuilding could assist the maximum output without impeding naval work, a review of the allocation of merchant programmes with the object of reducing the number of types of merchant ships built in the same yard, and a survey of all yards not now in use for shipbuilding, and the selection for re-opening of those which could most rapidly be brought into use. On the other hand, shipbuilding has not been delayed from lack of materials, and the main conclusion of the report appears to be that attention to the human side of personnel problems and to the organization of facilities and supplies of labour and materials in key with the demands of the country as a whole are the chief essentials to ensure the execution of a programme adequate to meet the country's needs.

TUBERCULOSIS IN WAR-TIME

TUBERCULOSIS in war-time has recently been discussed by Sir Arthur MacNalty in a Chadwick Public Lecture (see p. 676 of this issue). It is also the subject of an excellent report reviewing critically the available evidence and making recommendations, which has been prepared by a committee of the Medical Research Council (London : H.M. Stationery Office, 1942. 9*d.* net).

The Committee finds that there has been a significant increase in the incidence and mortality of tuberculosis affecting all age groups since the War began. Modern war creates social and industrial upheavals responsible for many factors which tend either to increase the risk of contact with tuberculous persons or to a lowering of resistance to the tubercle bacillus.

The Committee makes many recommendations for preventing further deterioration in the trend of tuberculosis mortality :

(i) To reduce the spread of bovine infection from milk, the widest possible extension of pasteurization should be undertaken.

(ii) To detect pulmonary lesions at an early stage, mass radiographic surveys should be made (*vide infra*).

(iii) Improvements in the care and after-care of infected persons are necessary, with special reference to increasing the number of available beds in sanatoria and to financial aid to the patients and their dependants.

(iv) In order to raise resistance to the tubercle bacillus, especially in susceptible groups of the population, close attention should be paid to the working conditions of young employees.

(v) Additional measures are suggested ; namely, the examination of contacts, investigation of tuberculosis in mental hospitals, propaganda to the medical profession and the public, and a re-organization of the tuberculosis services.

Mass Radiography

The Committee pays especial attention to the value of mass radiographic surveys of selected groups of the community to discover the disease at an earlier stage than in most cases when the diagnosis is first made. The technique of miniature radiography, especially by virtue of its speed and economy, has made mass surveying a feasible measure. It should be stated that a subject showing positive findings in the miniature radiograph is only regarded as a suspect until full clinical, bacteriological and radiological (full-size film) evidence proves or disproves the presence of significant disease.

Miniature radiography implies the photography of the fluorescent screen image produced by X-rays and is practised in two forms : (*a*) 5 in. × 4 in. miniature (as used widely in the United States) ; (*b*) 35 mm. cine film miniature recording. Many units using the cine film will shortly be available in Great Britain : a technical sub-committee (the report of which appears as an appendix) has laid down the requirements for this apparatus.

Mass radiography may be used:

(i) *Pre-employment*: examination of groups about to enter employment (e.g., the Services, industry).

(ii) *During employment*: examination of groups of persons, for example, in munition factories, without selection as to age or sex.

(iii) *Periodically*: examination of groups at regular intervals: this is regarded as the ideal method for the early diagnosis, and thus for the control, of pulmonary tuberculosis. In the difficult conditions of war-time, periodic mass radiography would probably have to be confined to specially selected groups, for example, munition workers, medical students and nurses, and merchant seamen.

In the main report, the Committee states that "mass miniature radiography requires a considerable degree of organization and planning ahead", but it is left to the Sub-Committee to emphasize that the method "should not be lightly undertaken. A very high standard of quality of miniature radiography is necessary for correct interpretation and the latter requires the highest radiological skill". It is of the greatest importance that every effort should be made to secure and preserve the highest technical standard: it is on this that the success of the method depends. The proposed vast surveys should be watched by a carefully chosen central advisory (or controlling) board of experts acting for the Ministry of Health.

TRAVELLING WAVES IN HIGH-VOLTAGE ALTERNATOR WINDINGS

A PAPER by E. Friedländer (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 11; October 1942) discusses the theory of this subject, pointing out that the security of the windings of an alternator generating at 22 kv. or above and connected directly to a network depends mainly on the ability of the insulation to withstand surge voltages. The distribution of surge voltages in the various types of stator winding hitherto adopted in commercial practice is examined, together with the relation of this distribution to that of the effective insulation available. As alternators nearly always operate with the neutral point of the windings unearthed, the voltage stresses on the insulation near the neutral in these circumstances are determined, and the danger of the use of graded insulation is discussed. In no case does there appear to be an inherent tendency for all transient voltages to be distributed over the length of the stator winding in the same proportion as the generated voltage of the machine.

The problem of the design of an alternator to generate directly at 22 kv. or 33 kv., or at higher voltages, appears to be best solved by avoiding graded insulation and applying the conventional methods of construction hitherto used for 6·6 kv. or 11 kv., the insulation being increased in thickness to carry the increased voltage. Such conventional windings have great inherent security against transient surge voltages, which affect chiefly the interturn insulation, and their major insulation can be easily and cheaply protected against more sustained over-voltages by means of surge arresters, preferably applied both to the terminals and to the neutral if this is unearthed.

These conclusions have arisen from theoretical considerations based on a number of approximations which, however, it has not been possible to check by experiment. Any experimental work, however, may be subject to considerable errors due to the depth of penetration of the flux into the iron of the core varying with the current of the conductors. The actual wave shapes found experimentally with low currents thus might not agree with the theoretical results, which are based on conditions that probably are better approached with heavy surge currents. The results obtained lend no support to the view that the distribution of the capacitances in the concentric-winding conductor would give even distribution of surge stresses over its different sections.

DISPLACEMENT METHOD OF WEIGHING LIVING ORGANISMS

A. G. LOWNDES has described* not only the method indicated by the title of his paper but also methods for determining the water content of living (especially aquatic) organisms and in some cases the density of their protoplasm. The accurate determination of the weight is (with marine animals) achieved by weighing a density bottle full of sea water and estimating the halide in the contents of the bottle gravimetrically, followed by a weighing of the bottle containing sea water and a living marine organism and an estimation of the halide content of the water in the bottle. All these data may be obtained with great accuracy and from them the author calculates the weight, volume and density of the organism.

The ratio of density of organism to density of medium (multiplied by 1,000 by the author and called the "sinking factor" or S.F.) is a measure of the effort that must be exerted by the organism to keep afloat. For the conger, the S.F. is 1,000, and so there is no tendency to sink, whereas the lobster with a higher S.F. will sink unless work is done to keep afloat, although the necessary expenditure of energy is reduced if the female lobster is carrying a load of eggs or embryos, because its S.F. is then lowered although its weight is, of course, increased.

The water content of aquatic organisms is determined by a modification of Dean and Stark's method, and here a novel technique is employed that obviates the introduction of errors due to the presence of extraneous water that wiping fails to remove. The author determines the water content of the animal and a known amount of sea water together, and from a knowledge of the composition of the latter, the amount of water in the organism is readily obtained by difference. In sponges that have been dried during a water determination, the silica is estimated and, making allowance for the presence of silica, the density of the living protoplasm is computed with a considerable degree of accuracy; minor modifications of the methods are necessary when freshwater organisms are being used. The interest of the methods lies in the high degree of accuracy attained, which makes possible investigation of the precise physiological and physical relations existing between aquatic organisms and their environment, and so paves the way for the advancement of knowledge in this field.

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* *J. Marine Biol. Soc.*, 25 (Oct. 1942).

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, December 12

BRITISH MYCOLOGICAL SOCIETY (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 2 p.m.—Miss E. M. Blackwell: "On Germinating the Oospores of *Photophthora cactorum*" (Presidential Address).

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at Caxton Hall, Westminster, London, S.W.1), at 2.45 p.m.—Dr. J. A. Bowie: "Management Today and Tomorrow".

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, Hampstead, London, N.W.3), at 5 p.m.—Prof. M. Polanyi: "The Scientific Community".*

Monday, December 14

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Major J. T. Wilson: "The Mackenzie Lakes to Hudson Bay and the Routes of Early Explorers traced on Air Photographs".

Tuesday, December 15

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. B. P. Uvarov: "The Locust Plague".

INSTITUTION OF CIVIL ENGINEERS (STRUCTURAL AND BUILDING ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 2 p.m.—Dr. F. M. Lea: "Modern Developments in Cements in relation to Concrete Practice".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. J. C. Drummond: "The History of our More Important Foods", (iv) "Fruits and Vegetables".*

Wednesday, December 16

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 6.30 p.m.—Discussion on "Soaring Flight" (to be opened by Comdr. P. A. Wills).

Thursday, December 17

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. R. P. Bell: "Recent Developments in the Theory of Reaction Kinetics in Solution" (Tilden Lecture).

Friday, December 18

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. J. W. Munro: "The Place of Research in the Control of Injurious Insects".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. Adolf Meyer: "The First Gas Turbine Locomotive"; Mr. A. J. R. Lysholm: "A New Rotary Compressor".

Sunday, December 20

WORKERS' EDUCATIONAL ASSOCIATION (GLASGOW BRANCH), ASSOCIATION OF SCIENTIFIC WORKERS (SCOTTISH AREA), WORKERS' EDUCATIONAL TRADE UNION COMMITTEE (SCOTTISH AREA), and the EDUCATIONAL INSTITUTE OF SCOTLAND (GLASGOW ASSOCIATION) (in the Glasgow and West Scotland Commercial College, Pitt Street, Glasgow, C.2).—Joint Conference on "Science and the Struggle for Freedom". At 10.30 a.m.—Prof. H. Levy, Prof. V. Gordon Childe and Dr. C. Ockrent: "Science in the Struggle against Fascism"; at 2.30 p.m.—Dr. Martin Ruheman, Dr. F. Haldane and Mr. C. R. Wason: "Science in the Soviet Union".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MASTER WITH GOOD QUALIFICATIONS IN SCIENCE, at the Southport Technical College—The Secretary to the Education Committee, Education Offices, 1 Eastbank Street, Southport (December 16).

TEACHER (MAN OR WOMAN) OF MATHEMATICS in the Technical Day School—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17 (December 16).

VETERINARY INVESTIGATION OFFICER under the Advisory Scheme of the Ministry of Agriculture—The Registrar, The University, Leeds (December 21).

HEAD OF THE ENGINEERING DEPARTMENT, at the College, Swindon—The Director of Education, Education Committee, Swindon (December 23).

SPEECH THERAPIST—The Education Officer, County Hall, Wakefield (December 24).

HEADMASTER of Felsted School—The Clerk to the Governors, Mr. Norman Orfeur, Solicitor, Braintree, Essex (December 31).

DIRECTOR of the National Froebel Foundation—The Secretary, National Froebel Foundation, 2 Manchester Square, London, W.1 (February 27).

SECOND ASSISTANT PORT ENGINEER (MECHANICAL) for the Basrah Port Directorate, Iraq—The Secretary, Overseas Manpower Committee (Ref. 541), Ministry of Labour and National Service, Hanway House, Red Lion Square, London, W.C.1.

ASSISTANT MECHANICAL ENGINEER for the Tanganyika Government Railway—The Secretary, Overseas Manpower Committee (Ref. 411A), Ministry of Labour and National Service, Hanway House, Red Lion Square, London, W.C.1.

ASSISTANT ELECTRICAL ENGINEER for the Nigerian Government Public Works Department—The Secretary, Overseas Manpower Committee (Ref. 538), Ministry of Labour and National Service, Hanway House, Red Lion Square, London, W.C.1.

ASSISTANT MASTER WITH GOOD QUALIFICATIONS IN ELECTRICAL ENGINEERING, at the Maidstone Technical Institute—The District Secretary, Mr. A. W. Peacock, 13 Tonbridge Road, Maidstone, Kent.

SENIOR OFFICIAL to be responsible to the Secretary for the work involved by the scientific activities of the Institution—The Secretary, Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1 (endorsed 'Science').

TEACHER OF ENGINEERING SUBJECTS—The Principal, Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal College of Surgeons of England. Scientific Report for the Year 1941–1942. Pp. 24. (London: Royal College of Surgeons.) [2310

National Physical Laboratory. The Technique of Calibrating Platinum Thermocouples for use in Liquid Steels. Pp. 8. (London: H.M. Stationery Office.) 2*d.* net. [2610

Summary Report by the Ministry of Health for the Period from 1st April 1941 to 31st March 1942. (Cmd. 6394.) Pp. 35. (London: H.M. Stationery Office.) 6*d.* net. [2810

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 3, No. 20: Aristotle, Newton, Einstein. By E. T. Whittaker. Pp. 231–246. (Edinburgh and London: Oliver and Boyd.) 1*s.* 3*d.* [2710

Royal College of Physicians of Edinburgh. Annual Report by the Curator of the Laboratory for the Year 1941. Pp. 16. (Edinburgh: Royal College of Physicians of Edinburgh.) [211

Tin Research Institute. Publication No. 111: Tin-Base Bearing Metals. By Dr. W. T. Pell-Walpole, I. C. Prytherch and Dr. Bruce Chalmers. Pp. 40. (Greenford: Tin Research Institute.) [311

Science and Technology in the Soviet Union. Pp. 32. (London: Marx House.) 2*s.* [611

Now or Never? Financial Principles in relation to Present Requirements. A Survey, with Certain Proposals, by C. Marshall Hattersley. Pp. 32. (Mexborough: S.C.C.C., Greno House, Swinton.) 6*d.* [611

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd. Twenty-seventh Annual Report, 1941. Pp. 74. (Cheshunt: Nursery and Market Garden Industries' Development Society, Ltd.) [911

University of Leeds. First Montague Burton Lecture on International Relations. By John Gilbert Winant. Pp. 8. (Leeds: The University.) [911

Philosophical Transactions of the Royal Society of London. Serie B: Biological Sciences. Vol. 231, No. 582: The Giant Myelinate Nerve Fibres of the Prawn. By W. Holmes. Pp. 293–312+plate 22–24. (London: Cambridge University Press.) 5*s.* [111

Other Countries

Bulletin of the American Museum of Natural History. Vol. 80 Art. 3: American Diptera. By C. H. Curran. Pp. 51–84. (New York: American Museum of Natural History.) [271

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 114: Plant Introduction. 1: A Review with Notes on Outstanding Species, by Dr. A. McTaggart; 2: Preliminary Selection and Evaluation of Pasture Species at Lawes (Queensland), by T. B. Paltridge. Pp. 30. (Melbourne: Governmen Printer.) [51

University of California Publications in Zoology. Vol. 46, No. 2 The Natural History and Classification of the Mount Lyell Salamander *Hydromantes platycephalus*. By Lowell Adams. Pp. ii+179–20 (plates 21–22). 35 cents. Vol. 46, No. 3: Distribution and Variatio of the Horned Larks (*Otocoris alpestris*) of Western North America By William H. Behle. Pp. iii+205–316. 1.25 dollars. Vol. 46, No. 4 Adaptive Modifications for Tree-Trunk Foraging in Birds. By Fran Richardson. Pp. iii+317–368 (plates 23–24). 75 cents. Vol. 48, No. 1 Mammals of the Big Bend Area of Texas. By Adrey E. Borell an Monroe D. Bryant. Pp. iii+62 (plates 1–5). 75 cents. (Berkele and Los Angeles: University of California Press; London: Cambridg University Press.) [61

Smithsonian Miscellaneous Collections. Vol. 101, No. 16: Th Snow and Ice Algæ of Alaska. By Erzsébet Kol. (Publication 3683. Pp. ii+36+6 plates. (Washington, D.C.: Smithsonian Institution.) [111

Proceedings of the United States National Museum. Vol. 91, No 3132: The Species of Aegla, Endemic South American Fresh-Wate Crustaceans. By Waldo L. Schmitt. Pp. 431–520+plates 25–2 (Washington, D.C.: Government Printing Office.) [111

U.S. Office of Education: Federal Security Agency. Educatio and National Defense Series, Pamphlet No. 12: Understanding th other American Republics (for Elementary Schools). Pp. vi+32 (Washington, D.C.: Government Printing Office.) 20 cents. [111

United States National Museum. Bulletin 181: The Cyclophor Operculate Land Mollusks of America. By Carlos de la Torre, Pau Bartsch and Joseph P. E. Morrison. Pp. iv+306+42 plates. (Washington, D.C.: Government Printing Office.) 65 cents. [121

Proceedings of the United States National Museum. Vol. 91, No 3131: Catalog of Human Crania in the United States National Museu Collections, Eskimo in General. By Aleš Hrdlička. Pp. 169–43 (Washington, D.C.: Government Printing Office.) [121

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ISAAC NEWTON, 1642–1727

CHRISTMAS DAY is the three hundredth anniversary of the birth of Newton, an event which, were it not for the conflict and chaos of these times, would have been celebrated on a world-wide scale, and marked by an international gathering of representative men of science in London and probably also at Grantham. In the present circumstances, we have to be content with more modest proceedings. Thus the Royal Society made its anniversary meeting on November 30 a Newton celebration, the Physical Society arranged a special lecture given in London and repeated at Cambridge, and a gathering at Grantham was addressed by Sir Henry Dale, president of the Royal Society.

It is on a similarly limited scale that the event must be marked in NATURE. Newton's life and work are surveyed by Prof. S. Brodetsky, of the University of Leeds. We also have the privilege of printing the addresses delivered by Prof. E. N. da C. Andrade, Lord Rayleigh and Sir James Jeans at the Royal Society's commemorative meeting. In the words of Sir Henry Dale, in opening that meeting, Prof. Andrade was asked to survey "the change which Newton's work produced, in the conceptions of the material universe which were current in his own times". Lord Rayleigh was asked "to deal, by demonstration where possible, with the experimental work of Newton and the great discoveries which he made by that method". Finally, Sir James Jeans was asked to give "some reassessment of the validity and permanence of Newton's system, in relation to the immense advances of knowledge in our own times".

In these four contributions, we believe we have a conspectus, brief as it must necessarily be, of the life and work of Newton. For more detailed accounts of the several aspects of Newton's work we must refer readers to the Supplement published with NATURE of March 26, 1927, on the two hundredth anniversary of his death. That issue included also a representative collection of portraits, and photographs of the well-known statue in Trinity College Chapel, Cambridge, and the Manor House at Woolsthorpe.

On p. 731 of this issue we reproduce an interesting document belonging to the Royal Society, which bears the signatures of both Newton and Halley. It was among the exhibits arranged by the Royal Society for the celebrations on November 30 last.

Newton's name will ever be remembered as the author of the "Philosophiæ Naturalis Principia Mathematica". Nevertheless, it is gratifying to know that, as the result of steps taken by the Royal Society, and through the generosity of the Pilgrim Trust, the Manor House at Woolsthorpe has been secured for posterity as a memorial. A suggestion made by Dr. H. Buckley in a lecture to the Institute of Physics (see p. 731), for a complete edition of Newton's works, is well worthy of consideration. As he pointed out, magnificent editions have been published at the expense of their countries of the works of Galileo, Huygens and Fresnel ; Britain has no such memorial of one who is rightly claimed as the most distinguished of natural philosophers.

NEWTON: SCIENTIST AND MAN

By PROF. S. BRODETSKY

ISAAC NEWTON was born on Christmas Day, 1642; he died on March 20, 1727. His life extended over one of the most significant and exciting periods in British history. When he attended the small village schools near Woolsthorpe in south-west Lincolnshire, Parliament gained its victory over King Charles I. When, as a boy of fifteen, he disappointed his mother's desire that he should administer the modest paternal farm, Cromwell died. When he returned to the Grantham School in order to prepare to go to Cambridge, and was passing through what was his only and unsuccessful romantic episode, the merry monarch King Charles II was restored. The Royal Society was founded when he was a young Fellow of Trinity. When at the age of forty-four his "Principia" was going through the press, he represented the University of Cambridge in its struggle against King James II. He refused to entertain any question of compromise, and approved of the revolution of 1688, for he represented the University as a Whig in the Convention Parliament of 1691. Although he took no part in the debates, for he was a very indifferent speaker and easily embarrassed when expected to make any statement unprepared, he played a considerable part in adjusting the relations between his University and King William III and Queen Mary. It was in the days of Queen Anne that he became the acknowledged representative of English science and received a knighthood. His death in 1727 was followed by the death of King George I, the first of that series of monarchs under whom British democracy was established.

From his graduation in 1665 until March 1696—a period of thirty-one years—Newton devoted himself to a career of scientific discovery which has not been equalled by any other human being. In 1696 he went to London at the invitation of his young Cambridge friend, Charles Montague, who had become Chancellor of the Exchequer, in order to act as Warden of the Mint, and for another thirty-one years he lived in the midst of national affairs. There has been a theory that between his great academic career and his London life Newton had gone through a serious illness involving mental derangement. There is no evidence that his mind was ever affected, although for a time he needed very careful attention.

During the second part of his life Newton retained his full mental vigour, and often carried out difficult mathematical investigations with great success. But it seems that he had lost interest in scientific discovery as such. There is no doubt that the services that Newton rendered to the nation in helping to improve the currency were of considerable importance; but having done this with success and achieved the reward of being appointed Master of the Mint—a semi-gentlemanly position with a large salary and small responsibility—he resigned his chair at the University of Cambridge and was very happy to be the doyen of British science for the remainder of his life.

As a young man Newton possessed two great passions—the love of calculation and the love of experiment. He evidently considered himself to be an experimentalist rather than a theoretical thinker. He devoted very long periods of time to laborious and complicated chemical experiments which led to no serious results. The fact that the man who established the mechanical method on which science has been based for two-and-a-half centuries was so intensely interested in the work of the alchemists of the Middle Ages, and devoted so much attention to the problem of converting base metals into gold, is an interesting illustration of the transition from the science of the Middle Ages to the new era inaugurated by himself: an era of unparalleled triumph in the mechanical interpretation of Nature, the philosophic foundations of which are only being questioned in our own day through the work of Einstein and the new quantum theory, based upon phenomena in the very large and the very small, far beyond any experimental evidence available until more than two centuries after the "Principia" was written.

Newton's aim seems to have been to explain natural phenomena in terms of forces acting on matter, and on the whole he refrained from framing explanations concerning the matter and the forces that he assumed in his work. His famous statement *hypotheses non fingo* was used when he defended himself against Leibniz's accusation that in his law of gravitation he had introduced occult methods into science and taught views contrary to a true belief in God, and really amounted to saying that his task was to explain under what laws things happened in Nature, and that he did not try to deal with the ultimate issues of the universe.

Newton's scientific work consisted of three parts: the optical, the mathematical, and the astronomical. It is scarcely necessary to explain what a remarkable achievement this work represented. It is sufficient to summarize the contents of the "Principia". This is not a text-book of existing knowledge with original additions here and there: it is one of the most original books ever written. The Galileo–Newton laws of mechanics are here formulated for the first time; the mathematical ideas required in the arguments, equivalent to the calculus, without which modern mathematics is unthinkable, are those invented by the author himself; the force of universal gravitation, invoked to explain the heavenly motions, is postulated as the result of Newton's own intuition; the study of fluid motions is initiated in order to dispose of the Cartesian hypothesis of heavenly vortices—the prevalent view held by all scientific men then; the phenomena explained in the "Principia" had never been in any sense satisfactorily explained before; the problems initiated, like lunar theory, planetary theory, shapes of planets, comets, tides, precession, etc., have occupied the best minds of humanity for centuries; the results achieved have been the admiration and inspiration of hundreds of mathematicians and astronomers, and will continue to be so for many centuries to come—and with it all there is a spirit of simplicity, dignity, sanity and soberness, and a grandeur of conception, that place Newton and his work on an unequalled level of eminence.

We are now living in a time when youth is "coming into its own"; often it is misled into hopeless misery. But youth is a characteristic of scientific progress. Einstein once said: "A person who has not made his great contribution to science before the age of thirty will never do so". This was abundantly true of Newton. His three contributions to knowledge—the spectrum, fluxions, and gravitation—were developing when he was a young man of twenty-three. The plague of 1665 drove Newton to his Lincolnshire home, and for a year or two he was more or less cut off from scientific contacts; but many notes made then testify to the growth of these ideas in his mind.

It is unimaginable that one person could have done all that Newton achieved, working alone without help or co-operation from others, interrupting his work by brief and no doubt almost unintelligible lectures, getting his recreation by walking in the little garden that was attached to his rooms at Trinity College, and often spending weeks on futile chemical experiments searching for something in the constitution of matter which he never understood, and which was quite beyond the understanding of those days. Few mathematicians or astronomers have read the "Principia": it is a unique experience to follow Newton's awe-inspiring genius in the original. It is a similar experience to read his "Opticks", and to think that the man who invented these remarkable experiments, leading on by unimpeachable logic to that which laid the foundation of so much of the physics, chemistry, astronomy and technology of the nineteenth and twentieth centuries, was at the same time almost in secrecy evolving new and revolutionary mathematical methods on which he based the "Principia".

Newton had done his work by the time he was forty-four. It is true that he published his "Opticks" when he was sixty-one, but the book largely represented his youthful work. He published later editions of the "Principia", and he made efforts from time to time to deal with lunar theory, but later workers built up systems, planetary and lunar, of which he dreamt. One can easily conceive the whole of Newton's scientific work after the "Principia" eliminated, without in any way affecting the place that he occupies in scientific history.

Newton spent much energy on non-scientific problems. He refused to take Holy Orders in order to retain his fellowship at Trinity, and got special permission from King Charles II to retain his fellowship while remaining a layman. This was not due to light caprice or indifference. Newton was deeply interested in theological philosophy. He had a thorough knowledge of the Bible; he recorded his views about God and Christ, and even attempted to publish—outside England—statements which implied doubts concerning fundamentals of the accepted faith. He was inclined to mystical views. But he was an anti-Catholic and not quite clear about the nature of miracles. He made a very clear distinction between human rights and divine sanction. It was Newton who wrote: "The authority of emperors, kings and princes, is human; the authority of councils, synods, bishops and presbyters, is human; the authority of the prophets is divine". He fought against royal attempts to exercise unlimited authority. He went to Parliament on two occasions as a confirmed Whig, and was a keen opponent of anything which gave to human beings powers that could only be attributed to the divine. It is difficult to compare political views in different periods, but it is not incorrect to suggest that Newton was what we would call to-day an advanced Liberal.

There is a fine streak in Newton's character, showing the immortal scientist behaving with the greatest care and kindness to young men in whom he saw signs of ability or genius. He was especially friendly with Halley, no doubt in gratitude for the way in which Halley carried the financial as well as the editorial responsibilities in the publication of the "Principia"; he was kind and appreciative of Roger Cotes, Colin Maclaurin, James Stirling; he supported the peculiar William Whiston. Newton was very generous even when he was not wealthy. He remained the owner of his small hereditary estate in Lincolnshire, and some of his letters indicate his intense interest in such minor matters as the inhabitability of cottages and the comfort of his tenants.

But Newton's life was spoilt by a series of quarrels with some of the most brilliant men of his time. Even as a young man he could not stand criticism of his scientific work, and announced that he would not publish anything at all if he had to be a "slave to philosophy" and spend his time answering criticisms. It seems that this was why he became an open enemy of that erratic genius Robert Hooke. John Locke described him as "a nice man to deal with", with the Shakespearian meaning of "nice". He had persistent quarrels with John Flamsteed, that brilliant, poor and modest first Astronomer Royal, who had to earn his living as a vicar as well as by private teaching, and who helped Newton with information for the "Principia" and for his efforts on lunar theory. Newton seems to have been a rather unworthy participant in the great controversy with Leibniz and John Bernoulli concerning priority in the discovery of the method of the calculus. These quarrels throw a peculiar light on his personal and scientific character, unworthy of a great thinker. He even wanted to leave the astronomical part of the "Principia" unwritten in case it was subjected to criticism. It seems that in his Cambridge life Newton wanted to be free from all discussion, so as to work privately and uninterruptedly on some things that were useless, and on some which form the glory of human discovery. When he was the public man in London he seemed to possess an extraordinary belief in his own achievements, and treated some other people in a way unworthy of a leader of science.

Newton made some serious mistakes in his scientific work. His optical ideas held up the development of the achromatic telescope, and were an obstacle to the evolution of the wave theory of light. It seems that his primitive theories on fluid resistance kept some people in our own generation dubious of the possibility of flight. Would he himself have disapproved of slavish subservience to his own authority?

One may be doubtful of this, but such was Isaac Newton, endowed with unimaginable mental qualities and with obvious faults; the down-at-heel professional bachelor of his academic days, and the rather wealthy Court favourite of his later years; the man who believed in freedom, who fought the tyranny of a king, and in his own way helped to develop British democracy. Newton was not a statesman or a politician. He was not technically a philosopher. He never recorded any social theory. But it is well to-day to remember him not only as the man who made the heavens intelligible to humanity, but also as a man who helped to give liberty to humanity so that it may be free to look up into heaven.

NEWTON AND THE SCIENCE OF HIS AGE

By Prof. E. N. da C. ANDRADE, F.R.S.

IT is my task—my honourable and inspiring task—to say something of Isaac Newton as seen against the background of the science of his time. I shall try to display briefly the position as he found it and to resume in a small space his great achievements and the changes in outlook which they produced. In praising Newton I shall endeavour to do justice to his great forerunners and to the men of his time who pursued worthily the same great ends as he did, and who would have held the centre of the stage in any other age than that dominated by him. For Newton, like Shakespeare, did not stand as a lonely adventurer into new realms, though he travelled farther and straighter than the rest. Shakespeare was the supreme poet and playwright at a time when poetry and plays were part of the life of every cultivated man and occupied the attention of the brightest intellects. Newton was the supreme scientist in an age when the quantitative method of questioning Nature was abroad in the air. Each was the child of his time.

Let us consider the position when Newton went to Cambridge in 1661. The hold of Aristotle, whose works had for centuries been the ultimate resort of all those seeking knowledge of the working of Nature, had been shaken off by such men as Galileo and Gilbert, but most of the learned still thought that those who relied on experiment were pursuing a futile and impudent course. The first resolve of Marlowe's Faustus

"Having commenc'd, be a divine in shew,
Yet level at the end of every art,
And live and die in Aristotle's works"

still represented the aim of many students. The foundation of the Royal Society in 1662 had been the occasion of many attacks on the experimental method, attacks stoutly met by Glanvill and Sprat, and as late as 1692 Sir William Temple's "Essay upon the Ancient and Modern Learning", satirized by Swift in "The Battle of the Books", set out to prove the superiority of the philosophers of the ancient world over all the moderns. Thus when Newton was a young man the new experimental method of questioning Nature was steadily making its way and the omniscience of the ancients was being called in doubt by a new school, but experimental science was by no means firmly established as a respectable study.

The great figures among the worthies of the exact sciences who had already appeared at that time were Copernicus, Tycho Brahe, Kepler, Gilbert, Galileo and Descartes. Kepler, following his great forerunners, had found the true laws of planetary motion, which were to be explained by Newton. Kepler's views as to the mechanism of the planetary motions were in his earlier writings largely mystical, involving the perfect properties of the five regular solids and also certain motivating souls or spirits. Throughout he held to the medieval point of view that a body could not maintain its motion unless there were a force propelling it. In his later writing he invoked a magnetic force, but it was not directed to the sun, like the true gravitational force, but pushed the planets on their way—"non est attractoria sed promotoria". It was essentially bound up with the rotation of the sun. Thus he was ignorant of the basic laws of mechanics, and his magnetic force had none of the true properties of magnetic forces. Kepler made no approach to a mechanical explanation of his laws. Gilbert had not only established the basic principles of terrestrial magnetism and carried out fundamental work on electricity, but also had invoked a force from the moon—a magnetic force it is true—to produce the tides. Galileo's greatest achievement had been to lay the foundations of mechanics.

None of these men, however, had made any impression on the bulk of the learned: Francis Bacon, for example, does not mention Galileo or Kepler, and refuses to take Gilbert seriously. The great figure in the eye of natural philosophers was Descartes, who had developed a cosmogony based upon mechanical principles, not precise mechanical principles it is true, but principles very different from the mystical ones then in vogue. Joseph Glanvill used to lament that his friends had not sent him to Cambridge, where he might have learned the new philosophy of Descartes, rather than to Oxford, where Aristotelianism ruled. Descartes' system had acquired such a hold on men's minds that his views were still supported long after Newton's death. Both Jean Bernoulli, who died in 1748, and Fontenelle, who died in 1757, were Cartesians to the end. The demolition of the Cartesian system was, in contemporary eyes, one of Newton's greatest achievements. James Thomson said, in his "Ode to the Memory of Sir Isaac Newton", published immediately after his death:

"The heavens are all his own; from the wild rule
Of whirling vortices, and circling spheres,
To their first great simplicity restored..
The schools astonished stood."

From the "Principia" it is clear that Newton himself derived particular satisfaction from having invalidated the Cartesian system. It is fitting, then, that we start our consideration of contemporary science by a glance at this system, not only because it was the only attempt before Newton to explain the motions of heavenly bodies on general principles, but also because it furnishes a contrast which brings out the essential Newtonian point of view.

Descartes starts, in the spirit of medieval thinkers, from certain general philosophical principles. He decides that the fundamental property of matter is extension—impenetrability, colour, hardness and so on are only secondary characteristics. Extension, which has three directions, is the subject of mathematics: motion is the subject of mechanics. All the different qualities of different kinds of matter are provided by different motions of the minute parts of which they are composed. "Give me extension and motion," declares Descartes, "and I will construct the world." One consequence of his fundamental belief is that there cannot be a vacuum, for extension without matter is a contradiction. He further considers, on theological grounds, that the quantity of motion in the heavens must be constant. He blames Galileo for founding his mechanics on experiments and not on reflexions on first causes. "Everything Galileo says about the philosophy of bodies falling in empty space is built without foundation: he ought first to have determined the nature of weight." Newton's point of view, of course, was the exact opposite to that of Descartes: he says in the famous letters to Bentley, ". . . for the cause of gravity is what I do not pretend to know, and therefore would take some time to consider of it"; and again, "gravity must be caused by an agent acting constantly according to certain laws, but whether this agent be material or immaterial, I have left to the consideration of my readers". For Newton, as for the best of his successors, science was concerned with the question of "How ?": Descartes, like the ancients, was concerned with the insoluble question of a fundamental "Why ?".

It followed from the philosophic hypothesis of Descartes that the only kind of motion possible in a plenum was a motion in closed paths, more particularly a circular motion, since a particle could only move if another particle took its place. It was on grounds of this kind that he elaborated his vortex hypothesis. Certain very fine particles, which filled interplanetary space, moved round ceaselessly in huge vortices and carried the planets with them. The moon was carried round the earth by a minor vortex, and so on.

Descartes' cosmogony, then, was founded on a philosophical system: it was pictorial and unquantitative. The paths of the comets handed on from one vortex to another were in particular irreconcilable with observation. There was no attempt to deduce Kepler's laws, or to show how anything but circular motion could result from the vortices. The whole scheme was spun from the brain of Descartes, with more or less casual references to actual phenomena. No doubt it was referring to Descartes that Roger Cotes said in his preface to the second edition of the "Principia", "Those who fetch from hypothesis the foundation on which they build their speculations may form indeed an ingenious romance, but a romance it will still be". In spite of, or perhaps because of, this, Descartes' influence was immense, and when Newton was at Cambridge as a young man it was Descartes who was the great authority for all such as speculated on the structure of the universe.

We now turn to the astonishing story of the birth of the "Principia". The time was ripe for the appearance of this great work. As regards the laws of motion, Galileo, whose services Newton freely acknowledges, and Descartes himself had done much to prepare the way for the more precise and particular formulation which Newton gives. Hooke among others had clearly expressed the protest of the most forward spirits of the time against the speculative method. "The truth is, the Science of Nature has been already too long made only a work of the Brain and the Fancy: it is now high time that it should return to the plainness and soundness of *Observations* on *material* and *obvious* things." The Royal Society was active in stimulating the pursuit of the new method, and on the Continent the Accademia del Cimento had done excellent work, while the Académie des Sciences was founded in 1666. These Continental societies had little influence on Newton, but are symptomatic of the general movement towards the experimental method. The stage was set for great things.

The story opens at Woolsthorpe, Newton's birthplace, whither Newton had come from Cambridge in June 1665 to escape the plague. He was then twenty-two years old and not yet a master of arts or fellow of Trinity. He had read what he calls "Schooten's *Miscellanies*" (probably the "Exercitationum Mathematicarum Libri V"), Descartes' "Geometry" and Wallis' works, and further was, of course, familiar with the work of his teacher Barrow. He had written his first treatise on the calculus, or 'fluxions' as he called it, but he had published nothing. The words which he wrote some fifty years later about this great springtime of his intellectual life have often been quoted but cannot well be omitted on an occasion like this. "In the same year (1666) I began to think of gravity extending to the orb of the moon, and having found out how to estimate the force with which a globe revolving within a sphere presses the surface of the sphere, from Kepler's Rule of the periodical times of the planets being in a sesquialterate proportion of their distance from the centre of their orbs I deduced that the forces which keep the planets in their orbs must [be] reciprocally as the squares of their distances from the centres about which they revolve: and thereby compared the force requisite to keep the moon in her orb with the force of gravity at the surface of the earth, and found them answer pretty near. All this was in the two plague years of 1665 and 1666, for in those days I was in the prime of my age for invention, and minded mathematics and philosophy more than at any time since. What Mr. Huygens has published since about centrifugal forces I suppose he had before me."

It seems likely that he had already his laws of motion in his head—in any case it is clear that he was convinced that every body would continue to move uniformly in a straight line unless some force acted on it, and that, therefore, there must be some force acting on the moon which drew it away from the straight line, tangential at any moment to its path, in the direction of the earth. Treating the moon's path as circular, from Kepler's third law, and from the law connecting the centrifugal force with the radius and the velocity, or the equivalent proposition to which Newton refers, it is easy to deduce the inverse square law. To show that the force keeping the moon in her orbit is the earth's gravitational force, assumed to diminish as the inverse square, is, however, a further step demanding a computation of how strong the gravitational force at the moon's orbit will be, compared to the measured force at the surface of the earth. Newton made this step and found it "answer pretty near". Why, then, did he delay the announcement of the law of gravity for twenty years or so ?

There is always a ready answer to questions of this kind where Newton is concerned—that he never published anything until invited, in general strongly urged, to do so. It is, however, clear from many signs that Newton was not himself satisfied about the matter until some time about 1685. The usual story is that he took a wrong radius for the earth, namely one corresponding to 60 miles for 1° of latitude instead of the correct value of about 70, but this story is very improbable on many grounds, one of which is that good values were readily available to him.

The real reason for Newton putting the work aside seems to have been that the calculation, so far as the force at the earth's surface is concerned, depends essentially upon it being legitimate to assume that the earth's mass may be considered as concentrated at the centre. That this assumption is valid is far from obvious. It is fairly clear from certain passages in "De Motu" and in the "Principia" that it gave Newton some trouble to prove this assumption and that he did it late. In a letter to Halley of June 20, 1686, he says, "I never extended the duplicate proportion lower than to the superficies of the earth, and before a certain demonstration I found the last year, have suspected that it did not reach accurately enough down so low". Although this refers to the gravitational force within a sphere, this and the point under discussion are involved in the same mathematical demonstration, which Newton gives in the "Principia" in Book 1, Proposition LXXI and other propositions following it. In any case Newton appears not to have been satisfied with his first calculations and to have turned to other things, possibly his optical experiments.

It is a strange thing that the "Principia" owes its publication largely to a quarrel with Hooke, and its sequel. In 1679 Hooke, then acting as secretary of the Royal Society, wrote to Newton about various scientific matters and asked him very civilly for a philosophic communication—a paper as we should say nowadays. He also asked for Newton's opinion on his "Potentia Restitutiva" and "particularly if you will let me know your thoughts of that of compounding the celestial motions of the planets of a direct motion by the tangent and an attractive motion towards the central body". In his reply Newton made an extraordinary remark. "But yet my affection to philosophy being worn out, so that I am almost as little concerned about it as one tradesman uses to be about another man's trade or a countryman about learning, I must acknowledge myself averse from spending that time in writing about it which I think I can spend otherwise more to my own content and the good of others: and I hope neither you nor anybody else will blame for this averseness." This is but one of many occasions on which Newton expresses his disinclination, almost distaste, for any further scientific work, his first antipathy having been aroused by the disputes and misunderstandings consequent on the publication of his first great work on the prism.

Nevertheless, Newton did comply with Hooke's request for something for the Society by pointing out that a body let fall from on high should strike the earth slightly east of the perpendicular, and gives precise and excellent directions for following out the experiment. The purpose was to prove the diurnal rotation of the earth. Hooke, in reply, pointed out that the ball should fall to the south as well as to the east, and further corrected Newton in a point which is too complicated to discuss here and one on which differences of statement can be due to different interpretations of the problem. This correction, tactlessly expressed, irritated Newton in the highest degree and he answered curtly. In further letters, written in apparent unconsciousness of the annoyance he had given, Hooke suggested quite explicitly that the law needed to explain the planetary motions was the inverse square law.

Now other men had come to the same conclusion. In particular, Wren and Halley had discussed with Hooke the possibility of explaining the mechanism of the heavens on the basis of an inverse square law. Hooke declared that he could demonstrate mathematically that the path of a particle in a central inverse square field would be an ellipse, but it is clear that he never did so, and equally clear that he had not the mathematical equipment necessary to begin an attack on the problem. He was in the unfortunate position of being entirely convinced of a truth that he could not prove. In August 1684 Halley visited Cambridge and asked Newton what the path would be. He replied that it would be an ellipse and that he had formerly calculated it. He could not find the calculation but soon sent a proof (or apparently two different proofs) to Halley.

This incident seems to have aroused Newton from the distaste for science into which he had fallen, and he put together the treatise "De Motu", founded on a course of lectures, which Halley presented to the Royal Society on December 10, 1684. The story of how Halley then coaxed and cajoled Newton into writing the "Principia" is familiar, but we in the Royal Society ought never to celebrate the great work without a tribute to Halley, who not only realized at once the fundamental importance and significance of Newton's work but also used all his tact to get the book written and made himself financially responsible for the production, the Royal Society being in financial difficulties at that time. We are not now in financial straits and shall, I believe, be glad to bear the expense of producing a second "Principia" when the genius of our age brings it forth. The book appeared in 1687, and bears the imprimatur of the then president, who, although he achieved nothing in science, is still remembered. He was Samuel Pepys.

The "Principia" is not an easy book to read. The proofs are all given in the form of classical geometry, although, since it is certain that at the time when it was written Newton was in possession of the fundamental processes of the calculus and of the methods of analytical geometry, it is unlikely that this was the form in which he first derived them. Whewell has said, "Nobody since Newton has been able to use geometrical methods to the same extent for the like purposes; and as we read the 'Principia' we feel as when we are in an ancient armoury where the weapons are of gigantic size; and as we look at them we marvel what manner of man he was who could use as a weapon what we can scarcely lift as a burden". Various conjectures have been made by Rosenberger, Cantor, Giesel, Gerhardt and others as to why he did not use the new methods: Rouse Ball thinks that he was probably unwilling to add to the difficulties by introducing a new mathematical method. Be that as it may, he had a horror of unfounded criticism, and, as he told Dr. Derham, "to avoid being baited by little smatterers in mathematics, he designedly made his 'Principia' abstruse; but yet so as to be understood by able mathematicians". That he did not underrate the difficulty of the work is clear from what he says in the beginning of Book III: "I chose to reduce the substance of that book into the form of propositions (in the mathematical way) which should be read by those only, who had first made themselves masters of the principles establish'd in the preceding books. Nor would I advise any one to the previous study of every proposition of those books. For they abound with such as might cost too much time, even to readers of good mathematical learning. It is enough if one carefully reads the definitions, the laws of motion, and the first three sections of the first book."

The first book contains certain definitions of space, mass and time which have afforded the more metaphysically inclined a theme ample enough for discussion. But we will here let them pass uncommented. The famous laws of motion owe much to the labours of previous workers, in particular to Galileo, whose services Newton clearly acknowledges. The simple laws of central orbits under an inverse square law are worked out in much detail and the laws of pendulum motion are developed, with due acknowledgments to Huygens, who had published his "Horologium Oscillatorium" in 1673.

In the first book the motions are all supposed to take place in a non-resistant medium. In the second Newton considers motions in a resisting medium, always with his eye on the Cartesian world system which he was intent to demolish. He deals with a resistance proportional to the velocity and a resistance proportional to the square of the velocity, and further points out different kinds of fluid resistance, which he later defines most clearly in the 28th Query appended to the third edition of the "Opticks", "for the resisting Power of the fluid Medium arises partly from the Attrition of the Parts of the Medium and partly from the *Vis inertiae* of the Matter", that is, partly from the viscosity and partly from the bulk motion of the medium. The latter resistance he assumes proportional to the square of the velocity. In this book he opens the way to the hydrodynamics of real fluids. In the part dealing with hydrostatics he proves the law of the diminution of atmospheric pressure with height. He then discusses the motion of the pendulum and is the first to suggest its use for making a survey of the gravitational acceleration. In another connexion he derives an expression for the velocity of sound, this being the first case of a calculation of the velocity of a wave from the properties of the medium. The only other point in this book to which I will refer is the calculation which Newton carries out on the motion of an infinitely extended viscous fluid in which a body rotating upon its axis is immersed. What he has in mind is the Cartesian vortex—"I have endeavoured in this proposition to investigate the properties of vortices, that I may find whether a celestial phenomenon can be explained by them". He effectively defined the force "arising from the want of lubricity in the parts of the fluid" as proportional to the velocity gradient, whence the term 'Newtonian viscosity'. He is thus the first to touch the mathematics of viscous fluids. He finds that the periodic time of circulation of the fluid carried round by the rotating sphere is proportional to the square of the distance from the centre of the sphere*, which is grossly inconsistent with Kepler's third law. Newton considers that his deduction is a clear refutation of the Cartesian vortices and, for once, almost gloats over his victory. "Let philosophers then see how the phenomenon of the sesquialterate ratio can be accounted for by vortices". He brings many other objections against the Cartesian vortices: he points out, for example, that a continuous supply of energy will have to be given to the sphere to maintain the motion, because "it is plain that the motion is proportionally transferred from the centre to the circumference of the vortex, till it is quite swallowed up and lost in the boundless extent of that circumference".

The second book of the "Principia" is the foundation stone of mathematical physics. In it Newton shows an extraordinary instinct for grasping the essentials of a problem—it would almost seem that he knew the solution in advance and added the proof as a concession to those less clear-sighted. The manner of his refutation of the Cartesian vortices introduces a new spirit into the discussion: no hypothesis about the heavens is tenable unless the quantitative deductions from it agree with observations.

The third book opens with an introduction where, after stating what has been done in the first two books, Newton sets down the superb sentence, "Superstat ut ex iisdem principiis doceamus constitutionem systematis mundani"—it remains that from the same principles we demonstrate the form of the system of the world. It is this third book which based celestial mechanics so firmly that what was done in the next two hundred years was rather extension of, and improvements on, the Newtonian method than anything radically new. Not only does Newton establish the movements of the satellites of Jupiter, Saturn and the earth, and of the planets round the sun (or rather, as he points out, round the centre of gravity of the solar system) in terms of his gravitational theory, but also he shows how to find the masses of the sun and planets in terms of the earth's mass, which he estimates quite closely to the present accepted value; he accounts for the flattened shape of the earth and other planets; calculates the general variations of g over the surface of the earth; explains the precession of the equinoxes by consideration of the non-sphericity of the earth; calculates the main irregularities of the motion of the moon and of other satellites from the perturbing effect of the sun; explains the general features of the tides; and finally treats the orbits of comets in a way that showed that they were members of the solar system and enabled the return of Halley's comet in 1759 to be accurately calculated. This brief and imperfect catalogue is merely a reminder of the scope of this extraordinary book, which drew from Laplace, no enthusiast, ". . . all this, presented with much elegance, assures to the 'Principia' preeminence over all the other productions of the human mind". The book closes with the famous general scholium which returns to the confutation of Descartes' vortices and says, concerning the cause of gravity, "Hypotheses non fingo".

Although the book was eagerly bought, the Newtonian method and discoveries made way but slowly. Biot says that of Newton's contemporaries three or four only were capable of understanding the "Principia", that Huygens only half adopted the ideas, Leibniz and Jean Bernoulli fought against them, and that fifty years had to pass before the great truth demonstrated by Newton was understood by the generality of men of science, let alone developed. No doubt the difficulty of the book had much to do with the tardy appreciation, outside a narrow circle, of its contents. The Cartesian scheme was easy, pictorial, general: the Newtonian difficult, mathematical, precise. The very method of attacking the problem was altogether new. The second edition appeared in 1713, edited by Roger Cotes, of whom Newton said, "if Mr. Cotes had lived we might have known something". The preface clearly shows that among the learned the Newtonian scheme had not been widely accepted. On the Continent the progress was still slower and it is generally held that it was Voltaire's "Elémens de la Philosophie de Neuton", which appeared in 1738, that led to Newton's work being appreciated in France. Incidentally, the story of the apple, which Voltaire had from Newton's niece, Mrs. Conduitt, first appeared in the second edition of Voltaire's book, in 1741. Later, it was in France that Newton's work was raised to great glory, when Lagrange and Laplace erected edifices of splendour and elegance on Newtonian foundations.

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* Actually this is an error, which appears never to have been pointed out, although Stokes has indicated the like error in the case of the rotating cylinder, which Newton works out. It should be the *cube* of the distance.

The optical work of Newton was perhaps his favourite study: at any rate it was that to which he gave what is probably the only enthusiastic reference which he ever permitted himself, when he said, of his fundamental discovery in the matter of prismatic colours, "being in my judgment the oddest, if not the most considerable detection which hath hitherto been made in the operations of nature". I do not propose to say anything of the beautiful experiments which form the backbone of the book, but a few words as to the Newtonian attitude to the theoretical aspect may be permitted.

The nature of colour had from the days of Aristotle been the subject of philosophical speculation. According to Aristotle, colours are a mixture of light and darkness, or of white and black, a view which, embellished and modified in various ways, survived Newton and appeared again in, for example, Goethe's writings. Descartes was apparently the first to break really new ground in comparing colours to notes in music: his view of light was that it was a pressure transmitted through the particles that filled all space, and he conjectured that a rotation of the particles might be the effective cause of colour, a view which presents inherent difficulties effectively exposed by Hooke. We may agree with Huygens that "Descartes has said nothing that is not full of difficulties or even inconceivable, in dealing with light and its properties". The medieval question as to whether light was a substance or an accident was still occupying the attention of even acute experimentalists such as Grimaldi, the discoverer of diffraction, whose book appeared in 1665. It was Hooke again, who, with his extraordinary flair for the truth, combined with an inability to overcome the last difficulties that stood between him and a convincing conclusion, initiated the modern views. In his "Micrographia", 1665, he expressed the view that light was a very quick vibration propagated with a finite velocity. He gave what is something like Huygens' construction for finding the wave front on refraction, but, since he thought that light travelled faster in a solid medium, such as glass, than in air, he found that in the medium the wave front must make an acute angle with the ray. It was with this 'obliquity' that he connected colour. "Blue is an impression on the Retina of an oblique and confus'd pulse of light, whose weakest part precedes, and whose strongest follows. . . . Red is an impression on the Retina of an oblique and confus'd pulse of light, whose strongest part precedes and whose weakest follows." For him blue and red were the primary colours, all others being mixed. There is no time to follow his extraordinarily acute experiments on the colours of thin plates, but it must be noted that his ill-tempered attacks were the cause of Newton expressing a disgust with science which nearly caused him to abandon her pursuit, and were, it is almost certain, the reason why the "Opticks" was not published until 1704, the year following Hooke's death. The quarrel between the two men, both, as is evident from their correspondence, capable of generous appreciation of the other's achievements, was exacerbated by Oldenberg, then secretary of the Royal Society, whose dislike of Hooke may have sprung from causes little creditable to him. Newton had been undoubtedly stimulated by his reading of Hooke's "Micrographia", and he was always very remiss in acknowledgments to him. Let us pay a tribute to poor Hooke, sickly and without position or powerful friends. He had not Newton's power of thought, but he was probably the most ingenious contriver who ever lived and was a shrewd and daring speculator.

Nowhere more than in his writings on light does Newton stress his dislike of speculation not firmly rooted in experiment. The first words of the "Opticks" are "My design in this Book is not to explain the Properties of Light by Hypotheses, but to propose and prove them by Reason and Experiments", and again, in the 31st Query appended to the third edition of that book, he makes his point of view very clear, saying "These Principles I consider not as occult Qualities, supposed to result from the specifick Forms of Things, but as general Laws of Nature, by which the Things themselves are form'd: their Truth appearing to us by Phaenomena, though their Causes be not yet discover'd. For these are manifest Qualities, and their Causes only are occult. And the *Aristotelians* gave the Name of occult Qualities not to manifest Qualities, but to such Qualities only as they supposed to lie hid in Bodies, and to be the unknown Causes of manifest Effects. . . . To tell us that every Species of Things is endow'd with an occult specifick Quality by which it acts and produces manifest Effects, is to tell us nothing." It is in the light of this that we must read the famous "Hypotheses non fingo". Newton, of course, did make hypotheses, and even called them such—for example, in "Principia", Book II, Section IX, his assumption as to the behaviour of viscous fluids is headed "Hypothesis", and there are other instances. All he meant was that he was reluctant to speculate beyond any possibility of quantitative deduction, to form conjectures the defence of which would be merely a matter of dialectics.

Newton's corpuscular hypothesis to account for the experimental behaviour of light is clearly a hypothesis, but we shall see how closely he adapts it to the observations. First, he points out that light cannot be a wave motion, or it would spread out on passing through an opening. He knew, it is true, the phenomena of diffraction, but he did not realize how by making the wave-length small enough this could be reconciled with the general facts of rectilinear propagation, for which a stream of particles seems best suited. He clearly saw that the phenomena of the colours of thin plates demanded a periodicity, and he introduced this into his theory by the hypothesis of fits of easy reflexion and easy transmission. It is clear that light is partly reflected and partly transmitted at the surface of a transparent body: Newton supposed that a light particle alternated at regular intervals between a state in which it was transmitted through the surface and one in which it was sent back. He put forward diffidently ("Those that are averse to assenting to any new Discoveries but such as they can explain by an Hypothesis, may for the present suppose . . .") the idea that the impact of the particle on the surface excited vibrations in the medium which, overtaking the particles, put them into these alternating states. We are forcibly reminded of modern theories. The length of the interval of the fit, corresponding to our wave-length, was greater for the red than for the blue, and Newton gives the interval for yellow light incident normally as just about the actual wave-length of yellow light. Unfortunately, the length of the fit depended on the angle of incidence. However, of his whole theory he says, "But whether this hypothesis be true or false I do not here consider. I content myself with the bare Discovery that the Rays of Light are by some cause or other alternately disposed to be reflected or refracted for many vicissitudes". When he comes to consider polarization, he has to endow his particles with 'sides', so that there was a lack of complete symmetry about the direction of propagation. In short, he gave his particles just those properties which interpreted the experiments and hence was led to endow them with a periodicity and a polarity. This brought him to assume subsidiary waves accompanying the particles when they interacted with matter.

There seems to be a general belief that Huygens, as against Newton, advocated something very close to the wave theory of light, as it was accepted in, let us say, 1900. Huygens' wavelets, however, lacked the essential properties with which Fresnel afterwards endowed them: they were not only longitudinal but also had what are practically particle properties, as exemplified by the fact that the pole, the place where the wavelet touches the envelope, alone is efficacious. He was just as incapable as Newton of giving a satisfactory explanation of diffraction.

If we are asked to state in a sentence what was the main effect of Newton's work on the thought of his time, I think that the answer must be that it was to establish the power and universality of the methods of quantitative science. To Galileo we owe the great service, one that cannot be too highly praised, of having made particle dynamics into a science, but he did not look beyond the earth for its efficacy or suggest the application of his methods to the relative movement of the parts of a continuous medium, such as water. Huygens founded the study of rigid dynamics. Hooke suggested and speculated with extraordinary ingenuity and acuteness. Newton, however, showed that three clearly enunciated laws of motion applied to all observable movements of inanimate Nature: they governed the motion of waves and projectiles, visible solids and invisible air, resisted as well as free movements. Together with the inverse square law they explained not only the gross movement of planets and the movement of the comets, which before had seemed capricious, but also details which nobody had ever considered as being mechanically explicable, such as the precession of the equinoxes. The problems of the tides and of the irregularities of the moon's motion he did not fully solve, it is true, but he did enough to convince mathematicians that they were soluble by his methods. After Newton's work had been assimilated, the body of natural philosophers accepted it as a commonplace that all terrestrial and celestial movements were explicable in precise and numerical terms by calculations based on a few general laws: before Newton most thinkers were ready to invoke *ad hoc* principles and occult causes, based on human and divine analogies, for any but the simplest terrestrial phenomena, and the few who were in advance of their times were feeling tentatively for solutions which eluded their grasp.

Even in such thoughts on chemistry as he published Newton was looking for an explanation in terms of attractions, though, strangely enough, in this science he never seems to have applied his own rule and made quantitative experiments. His work on light lies somewhat outside the mechanical scheme, but here again his insistence on the quantitative created a completely new attitude towards colour. It became a subject for measurement and calculation, rather than one for discussion in terms of generalities.

If we are to try to represent Newton's achievements by some modern analogy, to construct some imaginary figure who should be to our times what Newton was to his, we must credit this synthetic representative with, I think, the whole of relativity up to, and somewhat farther than, the stage at present reached—we must suppose our modern Newton to have satisfactorily completed a unitary field theory. In light we must credit him both with having established the existence of spectral regularities and with their explanation in terms of the quantum theory. Possibly, too, we must give him the Rutherford atom model and its theoretical development, a simple astronomy in little to correspond to the solar system. Let us, then, think of one man who, starting in 1900, say, had done the fundamental work of Einstein, Planck, Bohr and Schrödinger, and much of that of Rutherford, Alfred Fowler and Paschen, say, by 1930, and had then become governor of the Bank of England, besides writing two books of Hibbert Lectures and spending much of his time on psychical research, to correspond with Newton's theological and mystical interests. Let such a man represent our modern Newton and think how we should regard him. Only so, I think, can we see Newton as he appeared to his contemporaries at the end of his life.

There are no discontinuities in Nature and there are none in the history of science. No discovery or fundamental innovation is absolutely new, unconnected with past thought and the stirring spirit of its own time. Newton was not uninfluenced by certain of his immediate predecessors and of his contemporaries. The revolt from the introspective method of constructing explanations of heavenly and earthly phenomena by appeals to philosophic necessity had begun before his birth, and his time was rich in brilliant exponents of the experimental philosophy, whose names will always stand as stars adorning the story of science. To compare him with other men of his time and to recognize their contributions to the development of the physical sciences does not, however, lead us to think less of Newton's achievements but rather to wonder at them all the more. It is easier to estimate the size of a Colossus if there are statues of more than life size in its neighbourhood than if it stand alone in a desert.

Newton owed much to the pioneer labours of Galileo, who had founded the science of mechanics, and, in a different way, much to Barrow, whose great mathematical acuteness and sympathetic support were always at the disposal of the young Cambridge scholar. To Hooke he owed more than he was ever prepared to acknowledge. From his great Continental contemporaries, Huygens and Leibniz, he borrowed little, if anything. Possibly if mathematical advances were alone in question Leibniz would have to be considered for a place on the same level as Newton, but for Newton mathematics were merely a means to a physical end: his mathematical innovations may even be left out of consideration without grave injury to Newton's fame. There is no record of physical experimentation that can compare for mastery and elegance with the "Opticks", no work in exact science that produces the same impression of supreme greatness and power of thought that the "Principia" does.

The spirit of this age is a denigrating one, which, in a reaction from the earlier custom of representing great men as free from all blemish and weakness, delights in attempting to show that nobody much exceeds the common level. If an earlier painter might have left out Cromwell's warts, the painter of to-day might represent his face as one huge wart. I have read records of Newton's weaknesses and I know of the adumbrations of his discoveries that can be found in forerunners and contemporaries: I acknowledge that his earlier biographer shut his eyes to any incident, writing or action that might seem to detract from his perfection. Nevertheless, all things considered, I think that the contemporary judgment of his greatness can still stand, and that, if the Marquis de l'Hôpital's query as to whether Newton ate, drank or slept like ordinary men ("for I picture him to myself as a celestial genius") seems to our present-day sobriety an affectation, nevertheless we may agree that the line of Lucretius placed on the Trinity statue was well chosen and fitting—

> Qui genus humanum ingenio superavit
>
> "who excelled the human race in power of thought".

NEWTON AS AN EXPERIMENTER

By THE RIGHT HON. LORD RAYLEIGH, F.R.S.

THE duty has been assigned to me of telling you something about Newton as an experimentalist. As the result of a study of what is known of his history, it seems to me that among his various intellectual pursuits experiment was his first love and the love to which he was most constant. Strange though it be, he seems in some moods to have doubted whether his theoretical studies were worth while, and I do not recall any case where he expressed himself enthusiastically about them. On the other hand, he speaks of his optical work as "The oddest, if not the most considerable detection which hath hitherto been made in the operation of nature".

Newton loved the mechanical side of experimental work. As a boy he constructed sundials, and, what is more, fixed one of them into the side of the house effectually enough for it to be there a century later. A notebook of his boyhood shows him assiduous in collecting recipes for various kinds of drawing materials, and he notes methods of performing some (rather nasty) conjuring tricks. Later on, when he is making his reflecting telescope, it is obvious that he is a skilled amateur mechanic, at home in furnace operation. He builds his own brick furnace, prepares speculum metal, and is apparently more successful than the professional opticians of the time in grinding and polishing it to a satisfactory spherical figure. (The days of parabolizing were not yet.) It was not until a good many years later that they were able to put such instruments on the market.*

Asked in his old age where he got the tools for his work, he replied that he had made them himself, and could have achieved little progress without doing so.

There are occasional hints to be gleaned that Newton practised other mechanical arts. Thus, when he examines the colour of thin blown glass, it appears that he has the facilities for glass-blowing at hand, and was presumably able to use them.

So much for the base mechanical side. Newton, however, had what may be called the itch of experiment and instinctively examined in this way any natural phenomenon that excited his interest. This instinct is not a common one, and it would be of interest to investigate statistically whether it is more correlated with mathematical aptitude than with, say, an aptitude for literary and historical studies. Newton had all these. Although he experimented in other fields, such as mechanics, heat and electricity, and even in anatomy and physiology, his optical experiments are of much greater importance, and in the short time at our disposal we shall only be able to consider a part even of these. The fundamental researches on the composition of white light were read before the Royal Society in 1672, and afterwards recapitulated in his "Opticks" (1704), and we cannot do better than concentrate our attention on them. Although the results are common property nowadays, yet on an occasion like this we shall do well to go back to Newton's own methods and point of view, and to repeat his experiments as nearly as we can in his own way. We must be content to use the positive crater of the electric arc to represent the sun.

Newton's experiments on the spectrum are sometimes presented as if he had started out with the idea of examining the composition of white light. It is true that his "Opticks" (like his "Principia") introduces the various topics as theorems or problems proposed after the manner of Euclid. It does not seem likely, however, that he set out in the first instance to prove any proposition. He bought a prism at Stourbridge Fair (near Cambridge) in 1666, "to try therewith the celebrated phenomena of colours". It is clear from this that the prismatic colours were quite a well-recognized phenomenon at this time, and this is also shown by the circumstance that the art of cutting diamonds so as to display them was already long known. In Peacham's "Gentlemanly Exercises" (1612) reference is made to "A three square cristal prisme wherein you shall perceive the blew to be outmost next to the red", and Grimaldi and others had already experimented on the subject, though without arriving at clear views. We can readily imagine how Newton, handling the prism, would soon find that the colours were well seen in candle-light, but not in diffused daylight. It would not be a long step from this to try the effect on a beam of direct sunlight admitted through a hole in the shutter.

There is no reason to think that he did this with a very clear anticipation of what the effect would be. He was exploring a nearly virgin territory. His beam of sunlight passing through the hole produced an image of the sun. It was what we now call a pinhole image, though the hole need not be very small. Newton's hole was $\frac{1}{3}$ in. diameter. Then he interposed the prism (Fig. 1).

To most people the colours would seem the main

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* Among the first successful commercial makers of reflecting telescopes was James Short (1710–1768), whose instruments were of the Gregorian type. He is said to have made a considerable number of concave and convex mirrors, and to have 'married' them by trial of what pairs gave the best result.

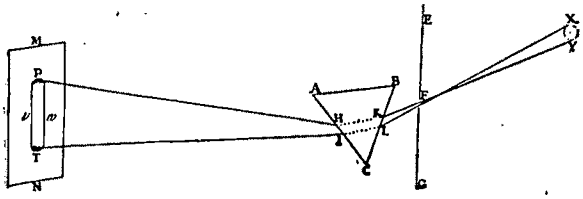

Fig. 1.

feature of this experiment, but Newton was more surprised and impressed with the fact that the sun's image was no longer round, but was spread out into a band of which the length was some five times the breadth. The breadth of the image as projected through the prism still answered to the sun's diameter, that is to say, it was equal to the diameter of the original round image of the sun at the same distance with the prism away.

"If," he says, "the refraction were done regularly according to one certain proportion of the sines of incidence and refraction, as is vulgarly supposed, the refracted image ought to have appeared round."

At the same time the colours had to be taken into account. Were the colours definitely related to the differences of refraction, or was the apparent relation only incidental? In Newton's words:

"Wherever this inequality arises, whether it be that some of the incident rays are refracted more, and others less, constantly or by chance, or that one and the same ray is by refraction disturbed, shattered, dilated and as it were split and spread into many diverging rays, as Grimaldi supposes, does not yet appear by these experiments, but will appear by those that follow."

The next experiment was accordingly designed to throw light on this point. It is known as the experiment of crossed spectra (Fig. 2), the idea being to refract each of the coloured rays a second time, in a direction at right angles to the former, and to see whether the blue rays, which were more refracted than the red, would be so again. Also to see whether they would retain their original colour, or whether they would undergo further analysis.

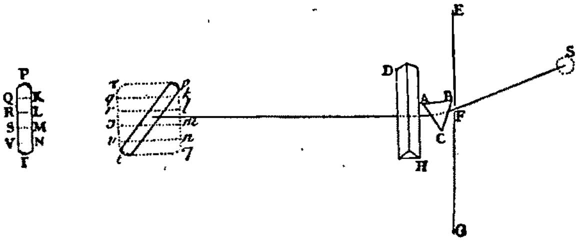

Fig. 2.

Newton made several more elaborate variants of this experiment. In one of them, two holes were used with a prism in front of each, and two spectra were then projected on the screen in line, the red of one following on the blue of the other. Refracting them upwards with a third prism, this line is dislocated, and that blue and red which were before adjacent are now widely separated (Fig. 3).

Newton in this way arrived at the view that the original white light of the sun consisted of coloured components, red, yellow, green, blue and violet. Each of these had a characteristic index of refraction and was bent to a perceptibly different extent by the prism. The result was that the original round white image of the sun was replaced by a series of coloured images side by side, overlapping and blending one with another. On introducing a second prism at right angles, each of these coloured images was again refracted to its characteristic extent and each retained its colour without further analysis.

Newton, however, soon saw the crudeness of his first arrangements, and we will now consider the methods he used to improve them. As he pointed out, the individual coloured images of the sun overlap at the middle, but not at the edges. Images of the sun are not in fact very suitable, because the angular width of the sun is about half a degree, and this is a considerable fraction of the angle between the red and violet rays. We want to make the sun in effect smaller, by blocking out part of its disk, which might be done in imagination by a distant diaphragm supported in mid-air. At the same time the hole in the shutter might with advantage be replaced by a lens, which would render the images sharper. When we have got so far in imagination, we notice that the long distance between the diaphragm in mid-air and the lens is not essential; with a suitable lens a moderate distance will do. We bring the diaphragm nearer, and fix it in the shutter, and bring the lens forward into the room, placing it so as to form a distinct picture of the diaphragm on the wall (Fig. 4).

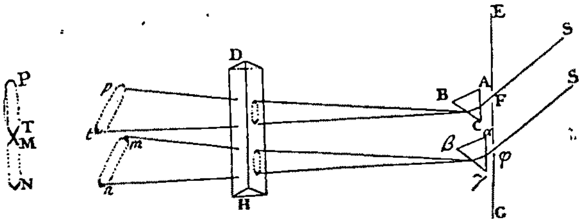

Fig. 3.

We have now the diaphragm fixed in the shutter, and backed by the sun, as our effective source of light. In this respect it differs altogether from the original diaphragm, which acted not as a source, but as an image-forming pinhole. We now have a picture of the diaphragm and not of the sun, and it will be advantageous to substitute a slit, which would not previously have been any use, because the size of the image was then defined by the angular diameter of the sun. With the slit *and the lens* we shall get narrow well-defined images in each colour, and the colours will be pure and not overlapping. (Needless to say, modern refinements carry the matter much further.)

The explanation I have just given is in substance Newton's own.

Let us now project the spectrum on to a small

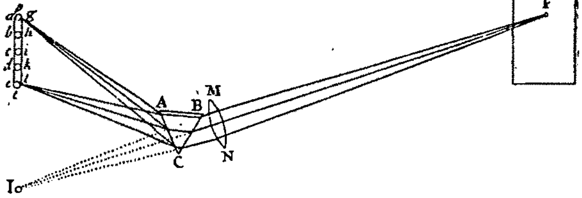

Fig. 4.

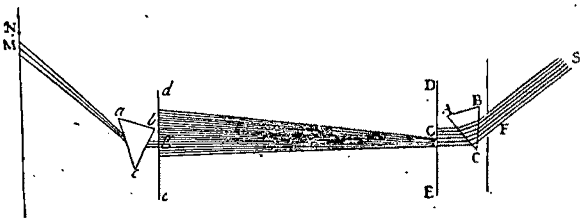

Fig. 5.

screen with a slit (Fig. 5) in it, which to avoid confusion I will call the screen-aperture. A colour passing through the screen-aperture is isolated, and if I rotate the prism, I can throw the various colours in succession on the slit in the screen-aperture, so that the image on a second screen is taken through the succession of spectrum colours from red to violet. Starting with it at the red, and placing a second prism in position behind the screen-aperture, the rays are deviated, as we should expect ; but there is no elongation of the image this time, nor is there any diversity of colour. The red image remains red. The same applies to any other colour of the spectrum that is passed through the screen-aperture. But as the successive colours are passed, from red to violet, the deviation on the second screen continually increases, the red being the least deviated and the violet the most.

This experiment shows essentially the same thing as the experiment of crossed spectra, but more perfectly.

The important point is that having once analysed white light into its prismatic constituent colours, this analysis is final, and further prismatic analyses can do no more. Further, each colour has its characteristic refrangibility, which will show itself at every refraction. Newton attached the greatest importance to this experiment, which he called, in Baconian phrase, the "experimentum crucis".

Having effected the analysis of white light into its constituent colours, he proceeded to reverse the process, and to show how the colours of the spectrum could be recompounded into white light. This he did by projecting the spectrum upon a large lens (Fig. 6), when the various rays were all converged to the same place and produced a patch of white light at the focus.

If a kind of large-scale model of a comb as used by Newton (Fig. 7) be placed in front of the lens, some part of the spectrum will be intercepted by the comb, and the white patch produced at the focus of the lens by recombination of the entire spectrum loses its whiteness, and becomes tinged with colour. The colours produced in this way are not pure spectrum colours, because any tooth of the comb permits colour from parts of the spectrum on either side of it to pass. The colours therefore are composite, but the complete spectrum is necessary to produce white. If the comb is moved slowly to and fro, the coloured patch varies, being now reddish, now yellowish, now bluish, but never white. If, however, it is moved to and fro as rapidly as may be, all the spectrum colours are present in succession. They blend by persistence of vision, and the patch becomes white again.

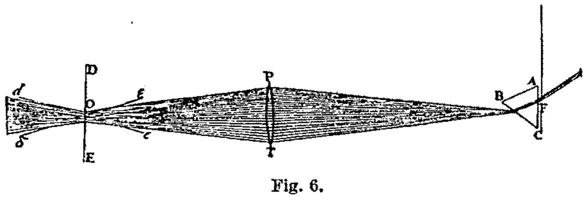

Fig. 6.

Newton devoted considerable attention to the colours of natural bodies, and he came to the conclusion that a coloured body is only coloured in virtue of its power of reflecting some of the components of white light more than others. When a spectrum is projected on a red screen, we see red light where we saw it before, and nowhere else. The colours are not altered, though red is the only one which is strongly reflected by the red screen. The others are mostly absorbed, and their place in the spectrum is comparatively dark. Red is advantageous for such experiments, as red pigments are much the purest in colour.

In another of Newton's experiments the spectrum is projected on a large lens as before. If a white card is held at the focus, it appears white, for all the colours are converged upon it. If a card painted with cinnabar (vermilion) is placed there, it appears red as usual. If we block out the red part of the spectrum at the lens, the card shows no trace of red, becoming comparatively dark. If we block out everything but red, the card shows up with a purer red than at first.

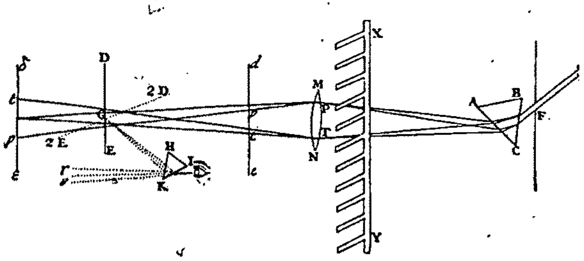

Fig. 7.

We have now been through most of the experiments by which Newton supported his main proposition "The light of the sun consists of rays differently Refrangible", following his own methods as closely as might be. They are a model for all time of how experimental research should be conducted, and it is difficult to our generation to see how any intelligent person could refuse his assent. This was by no means the unanimous opinion of his own contemporaries. One critic, Linus by name, maintained that the spectrum could only be seen when the sun was shining through cloud, and it is strange, but true, that Newton was seriously discomposed by this ridiculous mare's nest. Goethe bitterly attacked Newton, using abusive expressions, and apparently thinking that to use isolated beams of sunlight admitted into a dark room was treating Nature in an unfair manner, and compelling her under torture to say what she did not really mean !

The opposition to Newton's views did not finally die down until within measurable distance of our own time. In a book dated 1853, and dedicated to a man whom I as a boy personally knew, Sir David Brewster says : "The conclusion deduced by Newton is no longer admissible as a general truth 'That to the same degree of refrangibility ever belongs the same colour and to the same colour ever belongs the same degree of refrangibility'."*

* It is not intended to criticize Brewster adversely. The appearances by which he was misled are extremely deceptive.

Let us not make the mistake of thinking that Newton in his optical researches, exploring virgin ground, had easy triumphs. He did not escape the usual fate of discoverers. His jealous contemporary Hooke said his conclusions were not new; his admiring biographer, Brewster, concluded that they were not true!

Exhibits Illustrating some of Newton's Experiments

Arranged by Lord Rayleigh, as a supplement to those shown in his lecture.

"OPTICKS." BOOK I. EXPERIMENT I.

To show that lights which differ in colour differ also in refrangibility.

Newton's account abbreviated:

"I took a black oblong stiff paper. One part I painted into a red Colour, the other into a blew. This paper I viewed through a Prism of Solid Glass. I found that if the refracting Angle of the Prism be turned upwards so that the paper may seem to be lifted upwards by the Refraction, its blew half will be lifted higher by the Refraction than its red half. But if the refracting Angle of the Prism be turned downwards, so that the Paper may seem to be carried lower by the Refraction, its blew half will be carried something lower than its red half."

A.—"OPTICKS." BOOK I. PART II. EXPERIMENT XVI.

In this experiment a uniform field of light is viewed through a reflecting prism. Newton used the cloudy sky. An illuminated opal glass is substituted. The bright part of the field is the region of total reflexion. The relatively dark part of the field, corresponding to steeper angles of incidence, is the region of partial transmission and partial reflexion. A blue arc marks the limit of total reflexion. This shows that white light contains a constituent (blue) which begins to be totally reflected at angles of incidence less steep than are necessary for the other components.

"This blue colour being made by nothing else than by reflexion of a specular superficies seems so odd a Phenomenon, and so unaccountable for by the vulgar Hypothesis of Philosophers that I could not but think it deserved to be taken notice of."

B.—A supplement was arranged to this exhibit, allowing the transmitted light to be examined. A pair of right-angled prisms is used, forming a cube after the manner of Newton, reflexion occurring at the diagonal interface. The field is divided into a bright and a dark part as before, the dark part (no transmission) being the area of total reflexion. A reddish-yellow arc marks the limit of transmission, which is complementary to the blue arc seen by reflexion.

This experiment was performed by Newton in a more elaborate way, using the sun's light and projecting a spectrum of the beam transmitted by the cube.

"OPTICKS". BOOK II. PART I. OBSERVATION xiii.

An experiment showing that Newton's rings, formed between a spherical surface of large radius and a flat plate, are larger in red light than in blue. The observer can rotate the spectrum-forming prism and see the rings dilating as the colour is changed from blue or blue-green towards red.

"Appointing an assistant to move the Prism to and fro about its Axis, that all the Colours might successively fall on that part of the Paper which I saw by reflexion from that part of the Glasses where the Circles appeared, so that all the Colours might be successively reflected from the Circles to my Eye whilst I held it immoveable, I found the Circles which the red light made to be manifestly bigger than those which were made by the blue and violet. And it was very pleasant to see them gradually swell or contract according as the Colour of the Light was changed."

Newton recognized that this proved that there was a coarser structure associated with red light than with blue. In Query 13 at the end he says:

"Do not several sorts of rays make vibrations of several bignesses, which according to their bignesses excite sensations of several colours?"

AN EXPERIMENT ON FRICTIONAL ELECTRIFICATION.

From the Minutes of the Royal Society. 9 *December* 1675.

"That [Newton] having laid upon a table a round piece of glass about two inches broad, in a brass ring, so that the glass might be about one-third of an inch from the table, and the air between them inclosed upon all sides after the manner as if he had whelved a little sieve upon the table: and then rubbing the glass briskly, till some little fragments of paper, laid on the table under the glass, began to be attracted and move nimbly to and fro; after he had done rubbing the glass, the papers would continue a pretty while in various motions; sometimes leaping up to the glass and resting there awhile; then leaping down and resting there, and then leaping up and down again; and this sometimes in lines perpendicular to the table sometimes in oblique ones; sometimes also leaping up in one arch and down in another divers times together, without sensible resting between; sometimes skip in a bow from one part of the glass to another, without touching the table; and sometimes hang by a corner and turn often about very nimbly, as if they had been carried about in the midst of a whirlwind; and he otherwise variously moved every paper with a diverse motion. And upon sliding his finger on the upper side of the glass, though neither the glass nor inclosed air below were moved thereby, yet would the papers, as they hung under the glass receive some new motion inclining this or that way, according as he moved his finger.

The experiment he proposes to be varied with a larger glass placed farther from the table, and to make use of bits of leaf gold instead of papers, esteeming that this will succeed much better, so as perhaps to make the gold rise and fall in spiral lines or whirl for a time in the air, without touching the table or glass.

Ordered that this experiment be tried the next meeting."

A.—An apparatus with flint glass as used by Newton. Its action is uncertain, depending on the hygroscopic condition of the glass. It may fail, as it did when first tried at the Royal Society. Application had to be made to Newton for further directions. In dry weather and with vigorous rubbing it works admirably.

B.—An apparatus with silica glass. This can be taken out and warmed over a spirit lamp; it will then work without fail.

C.—An apparatus with a sheet of celluloid replacing the glass. This will work at any time without fail, if lightly stroked with the dry hand.

NEWTON AND THE SCIENCE OF TO-DAY

By SIR JAMES JEANS, O.M., F.R.S.

THREE hundred years have elapsed since Newton was born, and 276 since his fertile mind had conceived most of those fundamental ideas, the development of which was to add such lustre to his name and be of such outstanding value to science: in astronomy the idea of universal gravitation; in physics the theory of colours; in mathematics the differential and integral calculus (or, as he would have said, the direct and inverse fluxions) as well as the binomial theorem and the method of infinite series. He tells us he had thought of all these before he was twenty-four years old, although he wrote little about most of them until many years later.

The intervening years have seen Newton's ideas examined, tested and developed as no other set of scientific ideas ever has been, and it might seem that by now we ought to be able to assess his greatness and place him in his rightful position relative not only to the science of to-day, but also to that of all time.

We have no doubts as to his greatness, but we probably feel less confidence in our powers to assess his ultimate position in science than we should have done fifty years ago, and certainly less than his immediate successors felt. For they were not content merely to claim outstanding greatness for Newton; they went on to claim a quality of finality and uniqueness which we know better than claim for him to-day.

Laplace, for example, wrote that the "Principia" was assured *for all time* of a pre-eminence above all other productions of the human intellect, while Lagrange, after expressing himself in similar terms, went on to say that Newton was "not only the greatest genius that had ever existed, but was also the most fortunate, for, as there is only one universe, it can fall to only one man in the world's history to interpret its laws".

Such eulogies as these are in striking contrast with Newton's own modest estimate of himself. As his life was drawing to its close, he made the much quoted remark that to himself he seemed only like a boy playing on the sea-shore, "and diverting myself," he said, "in now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me".

Which of these two estimates, we may ask, is the nearer to the truth? And how far is it possible to reconcile them? Newton's contemporaries obviously could not have reconciled them. Can we?

All work in mathematics, no matter how modest it may be, may claim immortality if only it is accurate, since absolute truth can have nothing to fear from the disintegrating influence of time. But it is different with work in astronomy or physics. This must at best be relative to the knowledge, or even to the hypotheses, of its time, so that an increase of knowledge or an abandonment of hypotheses may at any time show it to be of no permanent value. This is as true of the work of Newton as of that of lesser men.

Yet Newton's contemporaries, as well as many generations after them, made the mistake of supposing that Newton's work in astronomy and physics possessed the same sort of absolute validity as his discoveries in mathematics; they thought that no future scientist would ever be able to penetrate to the innermost recesses of Nature's temple and discover more of her fundamental mysteries, because Newton had been there already and had seen all that there was to see. But we of to-day know that Nature's temple has many chambers, room after room, and that Newton had scarcely penetrated farther than the ante-chamber. Our thoughts turn to the work of Planck, Rutherford and Einstein. The ante-chamber which Newton had explored was familiar ground to them, but they found the keys to other, and hitherto unsuspected, rooms; in these they discovered laws every bit as fundamental as any that Newton discovered. We see that Newton was wiser than his contemporaries in his vision of the great ocean of truth which lay all undiscovered before him. But does this add to his intellectual stature or diminish it? Should it make him seem greater or less in our eyes?

There are some—although mostly laymen in science—who see science primarily as something that is for ever changing. For them the science of any period is like the sand-castles that the children build on the sea-shore; the rising tide will soon wash them away, and leave the sands clear for the new array of castles which will be built the next day. Those who hold such views are led, somewhat naturally, to make such statements as that Newton is out of date and superseded.

But the comparison is obviously faulty. Science is knowledge, and the primary characteristic of knowledge is not that it is for ever changing, but that it is for ever growing. Of course, all growth implies change, so that science must continually change—like the tree which is for ever budding out in new directions—but this is only a secondary effect. The correct comparison is not with sand-castles, which change because they are continually washed away and replaced, but with a vast building which changes as one floor is built on top of another, or a new wing is built where none stood before. This building is not like a medieval cathedral, the creation of a great number of artificers, each building after his own taste and fancy. It is an embodiment of scientific truth, and the truths of science are the same, no matter who discovers them. Whatever artificers build the structure, the blue-prints have previously been drawn by Nature herself, so that, had Newton lived or not, the building must at some time or other have looked pretty much as it looks to-day. And if we are to estimate how much modern science owes to Newton, we must not only consider how much Newton built himself, but also by how much he expedited the building—to what extent, to put it crudely, did Newton act as a catalyst to the growth and consolidation of scientific knowledge?

Let us first consider the significance of Newton's work in pure mathematics. There have been instances in this subject—especially in the theory of numbers—where a worker has stated a theorem which he believed to be true, but which centuries of discussion have not succeeded in either proving or disproving. Newton's mathematical work was not of that type. His *métier* was not the discovery of fanciful but comparatively useless theorems in recondite branches of pure mathematics, but the forging of practical tools which were urgently needed for further scientific progress, and we may be sure that if Newton had not forged them someone else would have done so in time.

For example, Newton hit upon the binomial theorem in two distinct ways. He, of course, knew the expansions of $(1 - x)$ raised to integral powers—squares, cubes, etc.; these are easily found by simple multiplication. Starting from these known expansions, Newton interpolated to find the values of the coefficients when $1 - x$ was raised to intermediate values, such as $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$. . . . He also calculated the value of $(1 - x)^{1/2}$ by taking the square root of $(1 - x)$ by the simple rules of schoolboy arithmetic, and of course found that the result confirmed what he had already obtained. It is hard to imagine that such simple artifices could have remained untried for long; the binomial theorem was simply a nugget lying on the direct road of progress, and it is quite inconceivable that generations of mathematicians could have passed it by without noticing it.

It was much the same with the greater discovery of the method of fluxions. Rouse Ball tells us that, before Newton appeared on the scene at all, the method had been foreshadowed in the writings of no fewer than seven mathematicians—Napier, Kepler, Cavalieri, Pascal, Fermat, Wallis and Barrow. In the more convenient and practical form of the differential calculus, it was actually discovered by Leibniz in 1675, and published to the world in 1684—nine years before Newton published his fluxional calculus. Apart from the personal questions involved, the bitter controversy as to whether the two discoveries were entirely independent, or whether Leibniz got ideas from seeing Newton's earlier letters on the subject, seems to me relatively unimportant; the calculus was simply another nugget lying on the direct line of scientific advance, and someone was bound to notice it and pick it up—if not to-day, then to-morrow; if not Newton, then Leibniz.

When we turn to consider Newton's still more famous work in mechanics and astronomy, we find the same story repeated; he did not drag science after him into peculiar paths of his own choosing, but kept to the broad main road, discussing the same problems as others were already discussing. The fundamental ideas with which he worked were not in any way novel, or peculiar to himself. His first law of motion had been given by Descartes in 1644, and indeed Plutarch had given it fifteen hundred years earlier together with a foreshadowing of the general principles of planetary motions, and the conception of gravity extending as far as the orbit of the moon. In his "De facie in orbe lunae", Plutarch had written, "You fear that the moon may fall, on the grounds that only light air circulates under the moon and that this is not adequate to bear a solid weight. But the moon is secured against falling by her motion and the swing of her revolution—just as objects put in slings are prevented from falling by the circular whirl. For everything is carried along by the motion natural to it, if it is not deflected by anything else."

Much the same, again, may be said about Newton's famous law of gravitation. The attraction of lodestone for iron had familiarized men with the idea that matter could attract other matter across empty space and, so far back as 1600, Gilbert in his "de Magnete" had conjectured that the earth might attract the moon like a magnet. Kepler had gone further in the same direction in 1619; we fi insisting on the mutual attraction of all matt instancing the tendency of all objects to fall towards the centre of the earth, as well as the ocean tides which, he maintained, were caused by the attraction of the moon. He said that two stones out in free space would approach one another, like mutually attracting magnets, and would finally meet at the point which we now call the centre of gravity of the two. He thought that the planets were kept moving in their orbits by some power inherent in the sun, and, although forming a very wrong idea of the nature of this power, he conjectured that it must vary as the inverse square of the distance. However, he immediately abandoned this law in favour of one varying inversely as the simple distance, a change which was challenged by Bouillard, who insisted that the true law must be that of the inverse square. Indeed, one of Kepler's own laws—that connecting the periodic times of the planets with their distance from the sun—shows clearly that the true law cannot be other than the inverse square law. Newton tells us that he had already noticed this in the plague years 1665 and 1666, but he did not publish it until it had been noticed independently by Hooke, Halley, Huygens and Wren.

Looking back on all this, we can scarcely accept Wordsworth's description of Newton's mind as

> "for ever voyaging through strange seas of
> thought alone."

Except in optics, where he voyaged alone because everyone else had lost the way, Newton's ideas were very much those of his contemporaries. His main achievement was not, as is so often stated, that he was the first to think of gravity as extending to the orbit of the moon, for this had been thought of fifteen hundred years before he was born. Neither was it that he was the first to think of universal gravitation, for many had thought of it before him. Neither was it that he was the first to conjecture that the force of gravitation must fall off as the inverse square of the distance, for this idea was generally current in his time. It was not even that he was the first to understand the general principle of planetary motions, for others understood these equally well.

Newton's great service to science, and through science to the human race, was not that he for ever voyaged through strange seas of thought alone, but that he voyaged through familiar seas of thought—if not in company with others, at least in seas that were much frequented by others. Bacon had written of his own contributions to scientific thought, that they did not originate in any mental powers of his own, but rather in the spirit of his age—"partus temporis potius quam ingenii". It was this same spirit of the age that moulded the form of most of Newton's contributions to science. Scattered scientific ideas—and unproved conjectures in particular—were floating around in abundance, and lesser lights of the firmament had made small, hesitating and uncertain advances in many directions. The age was crying for a man who could systematize, synthesize and extend the whole, and it found him in superlative excellence in Newton. But beyond all this, mental powers such as Bacon had disclaimed for himself were present in overflowing measure in Newton—"qui genus humanum ingenio superavit".

His special talents, as I see them, were: first that, out of a large mass of confused ideas provided largely by others, he was able, with his clear and acute mind, unerringly to pick out the true and discard the false; second that, having done this, his amazing mathematical ability enabled him to replace conjecture by proof, and so provide a firm basis from which he could unhesitatingly advance; third that he did advance, with quite incredible speed, sureness and directness, his supreme mathematical ability enabling him to outstrip all competitors with the utmost ease. From *conjecturing* that a thing is so to *knowing* that it is so, is usually a very long journey; it is one which Newton was so often able to take when his competitors were not. For example, Kepler had *conjectured* that the law of gravitational force might be the law of the inverse square; Newton *knew* that it could not be anything else. Kepler was so far from certain knowledge that he immediately abandoned this conjecture for another; Newton could not be misled into so doing, because his mathematical investigations provided him with convincing proof of the truth of his ideas. Having once settled his fundamental ideas and feeling full confidence in them, he was able to stride forward into the unknown with sure and rapid steps until he had unravelled almost the whole mystery of the then known universe.

In general it was not in originating ideas but in developing them that Newton's greatness showed itself most outstandingly; he was primarily a synthesist and systematizer. Yet here, as ever when we try to compress his genius into a formula or to map out its boundaries, an exception turns up to suggest that it overflowed all limitations; here it is the optics.

If we wish to understand the fundamental cause of his success, we cannot do better than read what Macaulay wrote in his "History": "In Isaac Newton two kinds of intellectual power which have little in common, and which are not often found together in a high degree of vigour, but which are nevertheless equally necessary in the most sublime departments of physics, were united as they have never been united before or since. In no other mind have the demonstrative faculty and the inductive faculty coexisted in such supreme excellence and perfect harmony." Einstein delivers a similar judgment even more forcibly: "In one person he combined the experimenter, the theorist, the mechanic and, not least, the artist in exposition. He stands before us, strong, certain and alone: his joy in creation and his minute precision are evident in every word and in every figure." And in truth he was unmatched both in the breadth and depth of his powers. Both contributed to his success. But if anything, the breadth was more in requisition, and so made the greater contribution to the success.

Yet if we are to estimate the extent to which Newton, with his outstanding mental power and unique combination of talents, expedited the growth of scientific knowledge, we cannot but place to the other side of the account his unfortunate habit of keeping his results to himself until they had been discovered independently by someone else. To some extent, this also may be ascribed to the spirit of the age. The seventeenth century had but little of our vision of science as a great benefactor to the human race, or of new knowledge as something which ought to be disclosed at once so as to expedite further progress by others. A man's scientific discoveries were his private property, with which he could do as he liked. Often his ambition was not to enable others to benefit from them, but to prevent others benefiting from them—this is why he would often publish his results in cypher. Or he might regard science, and mathematics in particular, as a sort of mental gymnasium in which contests of skill took place, and competitors issued challenges to one another to determine which of the two was the stronger or quicker. To use Newton's own metaphor, science was, more than to-day, a matter of playing with pebbles on the seashore, and seeing who could find the smoothest pebble or the prettiest shell. Thus there was less feeling of moral responsibility than now, perhaps even less interest in science for its own sake.

So we see Newton's terrifically powerful mind playing with the problems of science like a cat which plays with a mouse and loses all interest when he has killed it, or as we play with a crossword puzzle and regard the incident as finished when we have solved it.

We can see this exemplified in nearly all Newton's major discoveries. He tells us that he had thought of the method of fluxions in the plague year of 1665. Yet before publishing it even partially (except in cypher) to the world, he allowed twenty-eight years to elapse—years in which Leibniz discovered and published the same thing—and it was not fully published until 1736. Again in this same year of 1665, Newton satisfied himself that a force of gravity obeying an inverse square law explained the motion of the moon "pretty nearly", and was content to leave it at that. Later, he found that this same law would result in the planets describing the exact orbits they were known actually to describe—ellipses with the sun in one focus. Again he was content to leave it there. Most men would have published this as proof positive of the law of the inverse square, but Newton kept it to himself until Halley travelled to Cambridge to consult him on this very problem. Newton then explained that he had solved the problem five years previously, but had mislaid his proof. Finally, Prof. Andrade has reminded us of the reluctance with which Newton published his "Principia"—probably the greatest single work of the human intellect—and of the pressure which had to be applied before he would do so.

Apart from the general secretiveness of his age, we may perhaps find three further causes for this delaying tendency in Newton: an over-active mind which refused to halt by the wayside to perfect and write out results, a disinclination to be satisfied with anything short of perfection, and an extreme sensitiveness to criticism and consequent desire to avoid controversy, this resulting more than once in a disinclination to pursue the study of science any further. In spite of these handicaps Newton bestrode the scientific world like a Colossus: what would he have been without them?

Such was the man as I see him; let us now consider how much of the scientific edifice which Newton built, or was built under his influence, is still in useful service to-day.

Outside pure mathematics, Newton's procedure was simply that of every other true man of science. He started from known facts which, in his judgment, seemed likely to be related—as for example, if legend can be trusted, that apples fall to the ground with an acceleration of 981 C.G.S. units, and that the moon circles round the earth once every 27⅓ days—and tried to represent the isolated facts of such a group as special instances of a general system of laws. If this could be done, the set of laws so discovered could be made to predict other phenomena, which could then be submitted to the test of experiment or observation. If the laws passed this test, they were assumed to correspond to something in ultimate reality; provisionally at least they were true laws, and showed how Nature worked. If Newton differed from others, it was in the greater range of facts on which he worked.

In any scientific era, the search for such sets of laws is clearly restricted by the range of facts which are known, or are capable of being known, at the time; and we cannot expect scientific men to discover laws of a higher order of accuracy than the observations through which the laws are discovered.

Some may challenge this, arguing that a genius of sufficient stature ought to be able to discover the true reality behind Nature from quite meagre evidence—"ex pede Herculem"—and that, when this reality was known, the laws governing its behaviour could be deduced and would necessarily be true throughout the whole range of phenomena, whether known or still to be discovered. Unhappily, Nature is not like that. Science can, from the nature of things, never attain to a knowledge of the realities of the world, but only to a knowledge of the phenomena—of the impressions that the world makes on our senses, generally, of course, through instruments of precision. Our sense-organs form a sort of screen on which Nature's lantern is for ever projecting pictures; we can study these pictures, but can never pass behind the screen to see how the lantern works. As the sequence of pictures thrown on the screen is all that we can ever know or study, a set of laws that links the pictures together in a perfect systematic order is the most that science can provide, or can properly be asked to provide. If meagreness of the instrumental equipment in any age prevents the science of that age from knowing the finer details of the pictures, then we cannot expect the science of the age to provide laws governing these fine details.

For this reason we have to introduce a sort of relativity into our conception of the aims of physics; we may say that the science of any age can aim no higher than at predicting the result of any experiment that can be performed *in the age in question*. If this is conceded, we may claim that by far the greater part of Newton's work was accurate and final, relative to the age in which he lived; and this part is still of value and still in use to-day.

The enormous increase in instrumental power which has occurred since Newton's time has thrown open new fields for exploration in two directions—towards the infinitely great and towards the infinitely small, from the electron at one end of the scale to the nebulæ and the whole of space at the other. Man and the man-sized world with which Newton was mainly concerned lie about midway between these two extremes.

The laws of Nature are of course universal, so that the same set of laws must prevail throughout the whole of this range, but different aspects of these laws assume importance in turn in different parts of the range. So much is this the case that we may almost regard the different parts of the range as constituting separate and detached worlds in which completely different sets of laws prevail. There is the small-scale world of electrons and of atomic physics in general in which the laws of quantum mechanics prevail, the man-sized world in which the laws of molar mechanics prevail, and the world of the great nebulæ in which the laws of relativity prevail. These three worlds are all governed by the same laws, but factors which are all-important in one become mere insignificant corrections in the others. Newton's work was applicable almost exclusively to the middle-sized world of molar mechanics, and so not in general to the other two worlds, the existence of which was scarcely suspected in his day. Lagrange was wrong in thinking that there was only one universe, and that it could fall to only one man to interpret its laws; there are worlds within worlds, and Newton had only interpreted the laws of one of these. Relative to this world most of Newton's work was accurate and final, which means that it was also accurate and final relative to the age in which he lived.

If we examine any recent paper on theoretical physics, we are likely to find it plentifully sprinkled with either the symbol h or the symbol c, or both. These two symbols were unknown to Newton, at least in the sense in which we now use them; they are, so to say, the emblems of the theories of quanta and relativity which did not invade physics until the present century.

The symbol c denotes the velocity of light, which is greater than the velocity of any material object, and is usually enormously greater. Also in dynamical problems the ratio of these two velocities can only enter through its square. We are now familiar with electrons which move almost as fast as light, but the kind of dynamics with which Newton was concerned contemplated no velocity greater than that of the planet Mercury, which is about 48 km. a second. For this, the ratio of the squares of the two velocities is 0·0000000256, or, to seven significant figures, is *nil*. If we disregard this fraction, the dynamics of relativity becomes absolutely identical with that of Newton, so that to seven significant figures Newton's dynamics was adequate and factually perfect for an age in which nothing moved faster than the planet Mercury.

It is the same with the h of the theory of quanta. This measures the atom of action which Planck discovered in 1899, and although it is of the utmost importance to phenomena on the atomic and subatomic scale, it is absurdly small in comparison with the amounts of action involved in the activities of everyday life. Roughly speaking, the ratio is that of an atom to a gram, or of a gram to a star. This small quantity again was quite negligible in all the problems with which Newton was concerned.

Thus the Newtonian mechanics, dynamics and astronomy were absolutely right factually, except for quantities which were so small that they could not either affect Newton's problems in any way, or make their existence known through the best instrumental accuracy that was available in his day. To see Newton's work in these subjects in their proper perspective, we must think of him as the builder of the ground floor of the great building of mechanics, dynamics and astronomy, and as its architect for many floors above this. Newton's first and last serious contribution was his "Principia", but after this, floor after floor was added on strictly Newtonian lines: on the dynamical side, the generalized dynamics of Lagrange, Hamilton and Jacobi; on the astronomical side, the dynamical astronomy of Laplace and many others; on the physical side, the electrodynamical theory which we associate primarily with Clerk Maxwell. All this and much more followed the Newtonian architectural plan without any deviation whatever for two centuries. It was not until 1887—just two hundred years after the appearance of the "Principia"—that the Michelson-Morley experiment first showed that the Newtonian scheme was in actual fact imperfect. But the experiment had to be discussed for eighteen years before this inference was drawn, and it was only when Einstein's restricted theory of relativity appeared that the Newtonian scheme was generally recognized to be inadequate.

It is, however, inadequate only with reference to the ultra-refinements of modern science. When the astronomer wishes to prepare his "Nautical Almanac", or to discuss the motions of the planets, he uses the Newtonian scheme almost exclusively. The engineer who is building a bridge or a ship or a locomotive does precisely what he would have done had Newton's scheme never been proved inadequate. The same is true of the electrical engineer, whether he is mending a telephone or designing a power-station. The science of everyday life is still wholly Newtonian; and it is impossible to estimate how much this science owes to Newton's clear and penetrating mind having set it on the right road, and this so firmly and convincingly that none who understood his methods could doubt their rightness. Without his guidance, smaller men might have argued for centuries as to what was right and what was wrong. When Newton had spoken, it soon came to be recognized that the time for controversy as to which was the right road was past; it only remained to advance along the Newtonian road.

Newton's work in optics stands somewhat apart from the rest, in that he was much less indebted to his predecessors and contemporaries. Indeed, current ideas on the nature of light were so vague and erroneous that he was probably hindered rather than helped by what he knew of them, and was perhaps fortunate in not knowing more. We know that he attended the lectures of Barrow in Cambridge, where he would doubtless become acquainted with the optical theories of Descartes as well as with those of Barrow himself. Now Descartes thought that all space was filled with substance, and that vision resulted from the transmission of a pressure from one particle to another of this substance—much as a blind man pokes about with a stick. He thought that different sensations of colour resulted from the particles rotating with different speeds, red resulting from the most rapid rotations, and yellow, green and blue following in this order. Barrow held even more fantastic opinions; he thought that red light was more concentrated than light of other colours, but was broken up by intervals of complete darkness, yellow light consisted of a mixture of this red light with white, and so on. Hooke conjectured that light consists of a rapid vibrational motion of an ethereal medium filling all space, different colours being produced by different shapes of wave; blue, for example, resulted from "an oblique and confused pulse of light".

Into the midst of all this confusion of thought came Newton, to whom, in Einstein's words, "Nature was an open book, whose letters he could read without effort. The conceptions which he used to reduce the material of experience to order seemed to flow spontaneously from experience itself, from the beautiful experiments which he arranged in order like playthings." With the prism he had bought at Stourbridge Fair, he went at once to the crucial experiment of the spectrum. Finding that this was longer than it was broad, he at once saw that differences of colour must result from different degrees of refrangibility. This discovery alone, the subject of Newton's first scientific paper, published in our *Phil. Trans.* of 1672, at once took the theory of light leagues beyond the point to which any previous investigator had brought it, and opened the road to further rapid progress.

But Newton brought his views into discredit in the eyes of many by appearing to think of light as a material substance—Hooke definitely brought this charge against him. Actually Newton repeatedly claimed that his results did not depend on any special views as to the ultimate nature of light, and he was careful to avoid such words as 'corpuscles' which might seem to imply such views. Yet much of his thought seems to become meaningless unless we identify his rays—the "least parts" of light—with something of a corpuscular nature. However little he may have said about it, Newton seems always to have had his own picture of the structure of light before his eyes, and this picture was corpuscular.

For two centuries many thought of this as the one serious mistake that Newton ever made. Recently the pendulum has swung—perhaps too far—in the other direction. Light is a transfer of energy from matter at one place to matter at another, and this transfer can only take place by complete units, or 'quanta'. This led Einstein to picture light as a shower of arrows, each arrow containing a single complete quantum of energy, and some have hailed Newton's corpuscular theory of light as a brilliant prevision of this.

But we must remember that Newton introduced his corpuscles primarily to explain the rectilinear propagation of light, whereas Einstein introduced his light-arrows to picture the quite different property of atomicity. This being so, the similarity of the two pictures can scarcely be quoted as a supreme example of intuition on the part of Newton. It might be if light really did consist of corpuscles; Newton would then have arrived at the truth by one road two hundred years before Einstein reached it by another. But no competent physicist can for a moment suppose that light consists either of corpuscles or of light-arrows; these are only pictures we draw for ourselves to help us understand parts of a truth which we know, as a whole, to be for ever beyond our comprehension.

At this point we are inevitably brought to consider Newton as a philosopher. Unlike his great predecessor Descartes and his great contemporary Leibniz, he seems to have had very little interest in philosophy for its own sake. He was what we might describe to-day as a pragmatist; his main concern with a philosophy was not as to whether it was true, but whether it worked and yielded useful results. It was another illustration of the ever-recurring difference between the British and the Continentals.

Descartes had taught mathematicians to measure co-ordinates from fixed lines on a piece of paper. Newton wanted to be able to measure mechanical and astronomical co-ordinates in the same way from positions in space and instants in time. So he assumed without further ado that time could be measured from a fixed standard instant, and that the remotest parts of the universe contained vast immovable masses, providing standard positions against which absolute motion could be measured.

This assumption of the existence of absolute time and space was a mere working hypothesis which, as he admitted, might not be true at all: "it may be that there is no body really at rest, to which the places and motions of other bodies can be referred". But the assumption, whether true or false, produced results—nothing less than a consistent scheme which explained a large part of the then known workings of Nature. This being so, philosophers such as Bruno and Leibniz might argue in vain that absolute space, time and motion were meaningless and illogical.

It was much the same in mechanics. In the man-sized world of seventeenth-century science, motion was the result of pushes or pulls of the kind that a horse exerts on a cart. Other suggested causes of motion, such as action at a distance, were regarded much as we of to-day regard levitation or table-turning, and described as "occult qualities". It was inevitable that Newton's force of gravity should come under this description. Leibniz wrote, "Some men begin to revive, under the specious name of forces, the occult qualities of scholasticism, but they bring us back again into the Kingdom of Darkness". Newton's reply was a fine defence of his pragmatical philosophy. To understand the motions of the planets under gravity, he says, even though we do not know the cause of gravity, is as good progress in philosophy as is a knowledge of the motions of the wheels of a clock in the philosophy of clockwork, even though we do not understand why the weight which moves the wheels falls earthward.

At the same time, he refused to admit that his gravitational forces were not wholly mechanical. From the celestial phenomena, he said, we calculate the force of gravity with which bodies are drawn to the sun and the several planets. Once having found these, we deduce the motions of the planets, the comets, the moon and the sun, and "I wish we could derive the rest of the phenomena of Nature by the same kind of reasoning from mechanical principles".

It is interesting to speculate as to what might have happened if Newton had shared the views of Leibniz as to the relativity of all motion. It is conceivable that he might have arrived speedily at what we now call the restricted theory of relativity, that through it he would have seen the impossibility of action at a distance, and would then have developed a relativity theory of gravitation similar to that of Einstein. It is conceivable, but I can scarcely think it would have happened—the necessary physical ideas and mathematical technique seem to be centuries removed from the fields in which Newton worked. It is more likely that he would have been compelled to come down to an approximation which would have brought him back to the Newtonian mechanics and the inverse square law. If so, his erroneous philosophical background of absolute space and time was a real advantage, since it provided him with a short cut to a region which would have had to be explored anyhow as a preliminary to further progress. It enabled him to go direct to the main point as it appeared in the seventeenth century, neither hindered by any philosophical subtleties nor haunted by any fears that his system might not be an expression of final absolute truth.

In this way Newton created a system which, although philosophically unsound, was destined to endure for two centuries before any chinks were found in its armour. Then more philosophically minded Continentals had to be called in to patch up the deficiencies.

In this quality of practical and opportunist directness, as in many others, Newton seems to me to be typically British. In general he excelled where the British excel, and was weakest where the British are weak. If we think of his various pre-eminences in turn, and consider who runs him closest in each, we shall find it is usually a British man of science who comes to mind. If we try to match the simple directness and the clear logical sequence of his experiments in optics, our thoughts turn to our own Faraday and Rutherford. Clerk Maxwell runs second to him, I think, in other aspects of his work. But if we think of those who excelled him in his philosophical outlook, we have to think exclusively of Continentals, from Leibniz on. His successes were typically British, and his failures—in so far as he ever failed—were also typically British. We can not only be proud that this greatest of all scientific men was our own countryman, but we may reflect with satisfaction that he was no freak genius or sport, but was the concentrated embodiment of all the distinguishing characteristics of British science.

FUTURE OF UNIVERSITY EDUCATION

THOUGH the report (outlined on page 718 of this issue) of the Committee appointed by the British Association to consider university education after the War is only of an interim nature, it contains so much of outstanding and immediate value (if any of its proposals are eventually to be put into effect) that it warrants the close attention of all those interested in formal education and those who appreciate the valuable contributions which education will be able to make towards the new world order.

The Committee is obviously determined to pursue its policy of eliminating the defective and strengthening the weak spots in university education, of modifying certain systems and traditions, and of seeing that those universities which have suffered through the evil effects of actual warfare, or the even worse results of occupation by an unscrupulous enemy, are rehabilitated after the War. It is plainly anxious that all this shall be carried out in such a manner as to bring the maximum benefit not only to the universities immediately concerned but also to the whole international community. We tend at times to look upon university training as a means to an end which affects university men and women only; this is not only a very narrow but also a dangerous point of view, for universities are national institutions just like parliaments, and exist not only for the benefit of those who gain admission to them but above all for the community in general. The best material must be voted into them, and they must continue to make the best of that material so that their final products shall be not only a credit to themselves but also a distinct asset to the whole community.

Having read this interim report, we are satisfied that the Committee is treading the right path. It also indicates certain angles of approach which it proposes to make later on, and these indications, stated or implied, suggest that there will be much more for us to consider seriously when the final report becomes available. For that reason, only certain sections of the present report are sufficiently advanced to warrant useful comment.

The proposal that the 'modal' age of entry into the university should be nineteen is (apart from wartime contingencies) timely and deserving of support. Some of those actively concerned with university education have often expressed concern over the immature type of undergraduate gaining access to the universities. A first-year university student is in no way comparable to a sixth-form secondary school pupil, and the growing tendency to-day for a student to do his nominal first university year while still at school, and thus enter upon his second year when beginning his university career, makes the problem even more acute. When a student enters a university he finds himself thrown very much on his own resources, and often for the first time in his academic life has to make important decisions for himself in spite of university codes and regulations and tutorial supervision. Those university teachers who have had such students under their charge must often have noticed that many of them are too immature and indeed unready for such responsibilities.

Closely knit with the proposal to raise the age of entry, at any rate in its effect, is the Committee's proposal that a student should have given a year of national or international service or have had a year's education abroad before entering upon his university career, for thus will his mind be broadened and his sense of responsibility and of values be strengthened. Thus would students attain that greater appreciation of the value of social intercourse, greater maturity of mind and more experience of life, all of which have been so lacking for years past in our university freshmen. When they enter the university, they should be fit to take immediate advantage of the greater freedom from rules and regulations and of the fact that they are now treated as men and women and not as boys and girls. In present conditions too many fall victims to what is to them a new regime.

The comments of the Committee on entrance tests and scholarships will receive widespread support because such views have been expressed so often before, though, alas, little action has been taken. The present form of entrance examination is soul-destroying. The teacher in the school is tied not only by the examination system, but also by the peculiar requirements of that university which his pupils hope to enter. Though we would be the last to press for absolute standardization at the expense of individual development and expression, we strongly support the Committee's suggestion that there should be some form of standardization of examination so far as general education is concerned. Specific and special knowledge must, if necessary, be tested individually; but such a requirement should be imposed only in exceptional cases, otherwise the evil effects of examinations will always be with us. The time is also propitious for those universities which insist on a pass in certain definitely stated subjects in their entrance examinations to pause to consider whether such provisos (for that is what they really are) are necessary and, indeed, whether such rulings are not harmful. We have no quarrel with the demand for a reasonably high standard in English, mathematics, science, and other subjects of cultural value; but it is difficult to see the reason for making such subjects as Latin or Greek compulsory, as certain universities do. It is well known that in many such cases, candidates, who have never studied Latin before, read enough, after passing their School Certificate examination, in order to pass university entrance, and then begin forgetting all about it. Surely, with all due respect to a sincere study of the subject, this short-term cramming is an unnecessary waste of time and is quite meaningless.

The most potent effect of the Committee's proposals concerning this type of examination will be felt in both directions, that is, beforehand in the schools and afterwards in the universities. A better type of student would be the universities' share, whereas in the schools the pupils would profit by equality of opportunity and a more all-round training, especially from the social point of view.

It is recommended that all students should reside for at least one year in a university college or a hostel. It is also recommended that every student should be placed under tutorial supervision. These recommendations are complementary. But, though the Committee sets our minds at rest so far as expense is concerned, the difficulties will prove greater than one might on casual consideration think. Such difficulties as might arise will, of course, be least in the collegiate universities and in some of those modern universities, such as Reading and Manchester, which have developed splendidly comprehensive hostel or hall systems. The fraternity and dormitory systems extant in certain American universities would also lessen the difficulties. But a year's residence in a hostel would lose much, if not most, of its value if not lived fully and seriously. This would not be easy in many modern British universities situated in large towns which draw most of their students from their immediate surroundings. The hostel system in such cases would have to be subjected to very strict discipline if outside, especially home and town-life, distractions are not to exert a very adverse influence. Tutorial supervision is practised to a greater or less degree in most of our universities. In some, where it is scarcely anything but nominal, it needs tightening up. Much will depend upon the tutorial staff, who ought to be specially trained for the purpose, since they are more like teachers than lecturers. But the system itself would be greatly helped by some form of internal residence.

We can offer little but praise for the Committee's recommendations for re-planning teaching departments and curricula in accordance with modern conceptions of the interrelation of different branches of knowledge. In fact they have been borne out so recently as December 2 by the Archbishop of Canterbury, in a speech delivered in London, in which he said we should take note of the balance between human and scientific subjects. Dr. Temple considers that the pendulum has swung too far in the direction of scientific training. We tend to produce people whose conscious thinking is almost entirely governed by the methods of the laboratory, and whose minds only move freely when they are dealing with what can be measured, weighed and stated with exact precision. As Dr. Temple claims, this is not true of any human problem.

This carries our minds back to an address made by the same speaker about twelve years ago in Manchester, when he pleaded for more research in the universities. This side of academic life has certainly developed, and there may lie the cause of the problem. Too much of the training of university students is left to research specialists. Research specialists are bound to give prominence to their own pet interests, and thus are often unable to strike a balance for the average student. It is clear that both the narrow specialist and the broad general teacher are required in the university of the future, for very often the best teacher in the university is only a second-rate research worker, and vice versa.

It is therefore with a feeling of deep satisfaction that we note the Committee's insistence on training for world citizenship in all faculties, pass and honours, of our universities. No university is justified in granting a first-class degree to a student who has simply passed satisfactorily through its faculty of science. Social studies and the humanities must play a certain part in the training of all students. This applies especially to science students, for it is almost axiomatic that, in present circumstances, a man might gain a first-class degree in science and be no more appreciative of the essentials of world citizenship than any less fortunate individual who has not gone so far as through a secondary school.

One misleading remark in the Committee's report is that its recommendations for the institution of honours and pass schools of "Philosophy, Natural and Social" would meet the "charges of neglecting the non-vocational education of citizens". It may be true that the ideal university education should not be influenced by vocational demands, but the fact still remains that nearly every university student treats his university career as a basis or qualification for a profession usually chosen beforehand. It is also true that those university departments whose subjects offer little or no vocational value often find themselves practically void of students. In this claim, the Committee seems to be too modest, for surely such a school of "Philosophy, Natural and Social" should prove to be the very best one for the future school teacher. In their examination syllabuses, the universities themselves are in large measure responsible for the narrow and far too specialized training given in our sixth forms; but another reason may be found in the type of honours man usually chosen for teaching such boys and girls. Give him, not an honours degree in one subject, but what the newly proposed course can offer, and then our university candidates from the schools would receive a wider training in sociology and citizenship than they do at present.

The Committee's attempt to link up natural and social philosophy in the history of discovery is deserving of very careful consideration. In our studies of discovery we are recommended to include "natural science or scholarship, studied in relation to social and political history". This should help university, and even school, teachers to break away from the belief that they are doing enough when they bring into their science courses the study of the works of such paragons as Newton, Faraday, Boyle, Darwin and Harvey. In this connexion, teachers are recommended to read Dr. H. A. Mess's "Social Structure", where a considerable amount of background is offered for such courses as are proposed by the Committee. For example, the period between 800 and 400 B.C. was notable for its advances in ethical thought. There we find such names as Lao-Tze, Gautama Buddha, and the Jewish prophets from Amos to the second Isaiah. In Greece during the fifth and fourth centuries before Christ, considerable additions were made to knowledge, especially in mathematics, physics, medicine and biology. Socrates developed the method of argument, and Aristotle was the founder of formal logic. Rome followed during 100 B.C.–A.D. 400 with contributions to engineering, government and the formulation of law. And so one could go on. This is the history of discovery—not the discovery of natural laws alone, but also of human relations.

It is certain that our science students need a much broader and deeper background to their training. They need to be given training not only in scientific method but also in the interrelation of science with the other cultural disciplines. By giving them this we make them think of themselves not only as wheels in a machine concerned only with their own movements, but also as necessary parts of that machine, the working of which they seek to understand—the machine of human culture.

All this, the British Association Committee clearly bears in mind in its deliberations, and for this it is to be congratulated on a very valuable piece of work, which, nevertheless, is only partially completed. The Committee has, much to its credit, kept in mind the most important needs in our universities of the future, namely, equality of opportunity, freedom of development, thought and speech, the promotion of international collaboration, needs and service of the community—or in one phrase, training for world citizenship.

BRITISH ASSOCIATION REPORT

ONE of the important questions raised at the Conference on Science and World Order, which was held in London during September 1941, under the auspices of the British Association Division for the Social and International Relations of Science[1], was that of post-war university education and the rehabilitation of universities destroyed or damaged during the War. A Committee was consequently formed to examine and report on the problems involved. This Committee, under the chairmanship of Dr. J. C. Maxwell Garnett, is composed of twenty-four members (several representing universities outside the British Empire), together with the president and general officers of the British Association, and Prof. F. E. Weiss and Mr. A. Gray Jones as joint honorary secretaries. The Committee presented an interim report to the Council of the British Association in September 1942, and this has now been published[2].

Entrance to Universities

The Committee recognizes that those who enter upon a university career should do so with a greater maturity of mind and a wider experience of life than has hitherto been the case. The 'modal' age of entry into the universities should therefore be not less than nineteen. During their nineteenth year, students should carry out some approved form of national or international service (civil or military). Where possible, this work should be related to the intended profession of the students of applied science. For example, engineers should do a year of workshop training, and medical students might either enter a hospital or do some other form of welfare work. In other cases, a year abroad could be accepted as one form of international service.

Entrance examinations should consist of two parts: (1) a test of general education; (2) a test of special knowledge. So far as (1) is concerned, an ever-widening group of universities (beginning with all those in the United Kingdom) should adopt each other's tests. This would not apply to (2), but each department of each university should satisfy itself concerning a candidate's special knowledge. Though this recommendation would not be seriously impaired if certain universities still insisted upon every candidate for matriculation possessing, as part of a general education, some one particular kind of knowledge (for example, Greek or Latin) not required by other universities in the group, the Committee expresses the view that the adoption of its recommendations should be subject to no such exception.

Personal character (purposefulness, enterprise, initiative and originality) should receive careful consideration, together with the generally examined knowledge and intellectual qualities of a candidate when he is being considered for a university entrance scholarship. One of the greatest advantages of this, so far as each individual is concerned, would be to increase equality of opportunity. The schools themselves would also benefit in that they would thus be encouraged to provide more all-round training, especially social, by means of out-of-school activities.

For every internal student, at least one year's residence in college or hostel should be enforced. The Committee states that this would not involve a prohibitive cost; but further inquiries are being made. Personal direction and watching of every undergraduate's studies should be more fully developed by the adoption or extension of the tutorial system.

Freedom for discussion should be the keynote of all university education. Freedom of thought and expression, especially so far as world affairs are concerned, should be assured.

An International Auxiliary Language

International communication will be indispensable after the War, and the universities can contribute towards this by requiring all their students to be able to make themselves understood, by speech and writing, in some one auxiliary means of international communication. This is not a question of learning another language but of devoting one long vacation to the acquisition of an auxiliary means of communication. Basic English, for example, has only 850 words, whereas the English language contains 240,000, while French has 100,000 and Italian 80,000 words. A sufficient acquaintance with Basic English could be obtained within a few days by the many post-war students who will be able to talk some English. Professional diplomats can, of course, transact their business in a common language. Since it ceased to be Latin it has generally been French and is likely, in future, to be English. English is one of the two languages of the Anglo-Soviet Treaty and the common language of Generalissimo Chiang Kai-shek and the peoples of India.

The desirability of promoting the introduction of an auxiliary language as an international means of communication was given particular attention after the War of 1914–18, and the position and prospects of this subject were surveyed in a report of a British Association Committee published in 1921. In order to present the problem in a comprehensive manner, the Committee communicated with leading authorities and associations having special knowledge of classical and modern languages as well as interest in the use of an international auxiliary language. The particular claims of three types of such a language were stated, namely: (1) A dead language, for example, Latin; (2) a national language, for example, English; (3) an invented or artificial language, for example, Esperanto and Ido.

The advantages and disadvantages of each of these types were considered by the Committee, which reached the following conclusions: (1) Latin is too difficult to serve as an international auxiliary language; (2) the adoption of any modern national language would confer undue advantages and excite jealousy; (3) therefore an invented language is best. Esperanto and Ido are suitable, but the 1921 Committee was not prepared to decide between them.

However, since the publication of the British Association's report twenty-one years ago, the great political changes which have taken place, or which will have taken place at the end of the War, point to the fact that any auxiliary means of communication will have to be closely related to the English language. The Universities Bureau of the British Empire, and the new Association of University Professors and Lecturers of Allied Countries in Great Britain[3], might well assist in promoting the movement for an auxiliary means of international communication by preparing a report on the question whether Basic English is suitable for the purpose, or, if not, what alternative is to be preferred.

International Education Organization

Experience in university and other kinds of education gained by the different countries of the world should be pooled by the formation of an international education organization representative of teachers (including university teachers), governing bodies, local education authorities and governments. The wider utilization of graduate scholarships, sufficient to cover passage money and all necessary expenses, should aid the exchange of students between the universities of different countries.

The universities should also associate themselves more closely with non-vocational adult education.

Replanning University Curricula

Another term of reference of the British Association Committee is "To consider the replanning of teaching departments and curricula in accordance with modern conceptions of the interrelations of different branches of knowledge, particularly those of science and the humanities".

University studies are still showing a tendency to split up into a growing number of separate specialisms, very remarkable for their diversity. These tend to become increasingly removed from the life of the community. The Committee has therefore considered two proposals: *A*, a general degree course including both natural sciences and the humanities; *B*, a proposal to include courses of the elements of sociology and citizenship in the already existing specialized schools of natural and applied sciences.

The recommendations concerning *A* are partly derived from the proposals for an Honour School of Philosophy and Natural Science which were considered in 1923 by the University of Oxford and which have recently been informally revived. The crux of the recommendation is the institution of honours and pass schools of "Philosophy, Natural and Social". Here the modern world would be studied as an integrated whole against a background of modern science. The course of study would include the natural and the social sciences with the ultimate aim of constructing (as expressed in Whitehead's "Process and Reality") "a system of ideas which bring the æsthetic, moral and religious interests into relation with those concepts of the world which have their origin in natural science".

In such a course, chemistry and physics would come together under 'physical science', and zoology, botany and physiology under 'biological sciences'. During the study of these subjects, detailed knowledge would be looked upon as being less important than an apprehension of scientific method. Observational and experimental work would, however, have to be included. Along with these courses, there should be courses in the history of discovery, not only of inventions but also of ideas and conceptions. The study of man and society, including the contemporary international community, should be begun in the first year and extend through the next. The last year would then link together all previous work, whether in natural sciences or the humanities, and bring it in relation with the best philosophic thought of the Western world, begun by Plato and Aristotle and continued by the greatest modern thinkers from Descartes to Whitehead.

The Committee gives a warning against having separate tutors directing study of the separate subjects; the whole course must, to be effective, be treated as an integrated whole—an organized unity.

Proposal *A* is designed by the Committee to provide for the "non-vocational education of citizens". Proposal *B* should ensure that the importance of the interrelation of science and the humanities be also recognized in the specialized courses for students preparing for a professional vocation of science. For reasons stated by the Committee (and reiterated time and time again in NATURE and elsewhere), all students in the faculties of science should attend some discussion classes in subjects outside their specialism. Here such students should be addressed by persons who understand their background interest; the students are not recommended to attend courses of lectures in the faculties of arts and commerce.

There should be "special interest" courses; for example, medical students should attend courses on the public health services, vital statistics and human needs. These "special interest" courses should be followed by courses made up of discussion groups of a more general nature on citizenship, social and industrial relations, anthropology, psychology, and other branches of the humanities.

Such courses should cover the student's first two years, and should be enough to enable him to start thinking about social affairs, so that later on in his university career he will take complete advantage of the debating and political societies organized by the students themselves in their unions and guilds.

While claiming that all this is going in the right direction, the Committee warns against forcing the pace. The new teachers with the new outlook must eventually be created. This can be done, (*a*) by teaching general science in all schools, and (*b*) by providing courses in borderline subjects in the universities, such subjects to include social medicine and vital statistics in the faculties of science and medicine, social technology, demography and standards of human needs in the faculties of arts and commerce.

Rehabilitation of War-Damaged Universities

The British Association Committee has under survey the position regarding teaching material, apparatus, books and staff in universities which have been destroyed, damaged, disorganized or closed as a result of the War.

The Committee recommends that the United Nations should, at the time of armistice, require the enemy Powers to make full restoration of university property stolen or destroyed in the countries they have temporarily occupied.

Many scientific instruments and much apparatus now being put to war purposes would be of great value for teaching and research, and the Committee recommends that the Governments of the United Nations either give or lend them to the universities, especially those being rehabilitated after the War, and that they require similar action of the enemy Powers.

The Committee has obtained much information from the London International Assembly concerning war damage to the universities. Lists of up-to-date text-books as well as standard books and works of reference are being compiled. When these are sufficiently complete, they will be sent to British universities and university colleges and to the American University Union. It is then hoped to collect a large number of spare copies of such works. The Committee also recommends that the British Council consider buying certain books, and it is also hoped that publishers may supply, for the use of rehabilitated universities, books at reduced prices. It is also hoped to collect copies of learned journals or microfilms of them. The Committee may be able to arrange for the preparation of such microfilms.

It is the opinion of some members of the Committee, who are citizens of the Allied States in Europe, that it will be necessary for British and American universtities to train teachers and research workers for some of the universities whose staffs have been killed or dispersed by the enemy.

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[1] NATURE, 148, 331, 388, 393, 424, 426, 454, 456 (1941).

[2] "The Advancement of Science", 2, No. 7, 255 (1942). British Association, Burlington House, London, W.1. 5s.

[3] NATURE, 150, 692 (1942).

RECENT ADVANCES IN OUR KNOWLEDGE OF THE PHOTOGRAPHIC PROCESS*

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WHILE many materials are sensitive to light and can be used for making photographs, the present art of photography is based upon one specific process: the light-sensitive material is silver bromide in the form of extremely small crystals held in a layer of gelatin.

The direction in which advances have been made in recent years is in the elucidation of the structure of the light-sensitive materials and the factors which produce great sensitivity in the silver bromide crystals, so that very small amounts of light are sufficient to make them developable; in the study of the action of light itself and of the change which occurs in the exposed crystals; and in the study of the development reaction by which the exposed crystals are reduced to metallic silver.

The nature of the silver halide crystals and the origin of their sensitivity were elucidated between 1920 and 1930. An adequate theory of the nature of the reaction of light has only become available in the last three or four years, and our views as to the nature of the development reaction have changed very radically in the last year or two.

About twenty years ago, an attack was made on the origin of the sensitivity of the silver bromide crystals by three groups of investigators—Svedberg and his collaborators in Sweden, the British Photographic Research Association in England and the Kodak laboratories in Rochester, N.Y. Soon after gelatin emulsions were first made, it was found that the exposure required in the camera was greatly lessened if the emulsion had been cooked for some time at a high temperature or if it had been treated with ammonia. It was observed that the grains had grown larger during this treatment, and it was concluded that their greater sensitivity was due to their greater size. This is true, but it is by no means the whole story. For a long time, it had been known that if an emulsion were treated with some chemicals, such as chromic acid, it lost its sensitivity, even though the size of the grains was not changed. Also, sensitivity depends very much upon the particular kind of gelatin used in making the emulsion. No clue to an explanation was found until Dr. S. E. Sheppard studied systematically the various fractions obtained at each stage in the preparation of photographic gelatin.

Photographic gelatin is made from clippings from the skins of calves. For this purpose, the skin of the face and ears is used because these parts are of no value for leather. These clippings are first washed and then treated with lime for a long time to remove the fat and hair. The lime is removed by long washing with weak acid and then with water. Then the material is cooked in steam kettles until the gelatin is extracted, and the extract is concentrated if necessary and allowed to set to a jelly; the blocks of jelly are cut into thin slices and stretched out on nets to dry. Sheppard found that in the acid liquors in which the limed clippings had been washed there seemed to be a concentration of some sort of sensitizer, eventually identified as mustard oil, which contains sulphur.

When mustard oil is treated with alkali, it forms allyl thiocarbamide. If silver bromide is treated with a solution of allyl thiocarbamide, the surface of the silver bromide is attacked and grows a mass of white needles containing both allyl thiocarbamide and silver bromide. When these are treated with alkali, they break down into little black spots which must consist of silver sulphide because of the chemistry of the reaction.

When the development of grains is observed under the microscope, it starts from specks, these increasing in number and size until each grain is transformed into metallic silver. The question arises as to whether these centres of development existed before exposure or came into existence when development started. Sheppard's work put the whole matter beyond doubt. Sensitivity depends upon the existence of specks far too small to be seen in the microscope, and these specks consist of silver sulphide, probably derived from the mustard oil in the gelatin. The amount of

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* Abridged from *Scientific Monthly* (Lancaster, Pa.), 55, No. 4, 293–300 (Oct. 4, 1942).

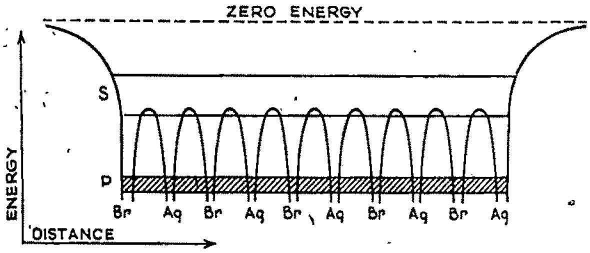

Fig. 1. ENERGY DIAGRAM OF A SILVER BROMIDE CRYSTAL.

mustard oil in an emulsion is very small. A ton of emulsion contains only a couple of drops, and the evidence for the existence of the sulphide specks is therefore indirect.

When Sheppard found that the sensitizing specks consist of silver sulphide, he and his colleagues advanced a theory of the action of light which they called the 'concentration speck theory'. The silver sulphide specks, they suggested, are formed on the surface of the silver bromide crystal and must in some way enter into the lattice of atoms of which the crystal is composed. They produce strains in the crystal, therefore, and these strains stretch into the surface of the crystal as an area of weakness. When light falls on such a crystal, energy travels through the crystal until it reaches the boundary of the speck. At this boundary, owing to the sudden change in structure, metallic silver is set free from the silver bromide. The sensitizing speck thus acts as a nucleus for collecting or concentrating the energy throughout the whole area of the crystal and for liberating metallic silver at the speck itself.

There was still wanting a mechanism for the operation of this concentration speck theory. Such a mechanism has been supplied by the work of Dr. R. W. Gurney and Prof. N. F. Mott and of Dr. J. H. Webb. In the first place, if we consider the energy diagram of a silver bromide crystal as a whole (Fig. 1), there are two energy levels of importance in the photographic process, the *S* and *P* levels, in which the electrons may be situated. The *S* band is normally empty and is referred to as a 'conduction band'. The *P* band is normally completely filled with electrons. Upon exposure of a silver bromide crystal to light which is absorbed in the long wave-length end of the characteristic absorption band, the electrons are transferred from the lower *P* band to the *S* band, and the crystal becomes conducting. This property is well known in other materials, as well as in silver bromide, as 'photo-conductance', and the silver bromide crystal exposed to light may be imagined to be filled with a sort of gas of conducting electrons. This is the primary photographic process—the thing that happens instantly when light falls on the crystal (Fig. 2). When the electrons set free in this way reach a sensitivity speck, either consisting of an impurity or of the silver sulphide derived from the gelatin, the electrons will be trapped and the sensitivity speck will become negatively charged by the electrons that it has absorbed.

In a crystal there are always mobile silver ions in the silver bromide lattice, and these silver ions will travel through the crystal until they reach a sensitivity speck, and there the charge on the ion will be neutralized by the negative charge on a trapped electron and the silver atom freed by the discharge of the ion will be deposited at the sensitivity speck, so that the electrons set free into the conductivity level by the original exposure to light are eventually transformed into silver atoms deposited on a sensitivity speck. This theory postulates that the production of an image by the action of light occurs in two stages: first, the release of free electrons which occurs instantaneously, and then the transfer of the free electrons by neutralization through the silver ions into silver atoms at the sensitivity specks.

This theory of Gurney and Mott supplies a mechanism for the phenomenon known in photography as the 'failure of the reciprocity law'. Bunsen and Roscoe found that, for the photochemical production of hydrochloric acid, time and intensity were reciprocal. That is, the production of hydrochloric acid was independent of the rate at which light energy was supplied and was dependent only on the total amount of energy. In the case of photography, however, it is well known that the effect of light is not independent of the rate at which it is supplied. There is an optimum rate for the formation of the maximum amount of photographic image, a rate corresponding to an exposure of a small fraction of a second. If the exposure is much greater than this—an hour, for example—two or three times more energy may be required to produce the same density of deposit. On the other hand, if the exposure is much shorter—a ten-thousandth or hundred-thousandth of a second, for example—somewhat more energy will be required. In order to account for the inefficiency of very low intensities of light in producing an image, it must be assumed that the silver atoms formed at the sensitivity specks can easily be lost in the early stages of the formation of the image by acquiring a positive charge owing to thermal action. Thus, for example, newly liberated silver atoms would be more easily lost than those which have entered a silver crystal lattice to form metallic silver.

On the other hand, with high intensities of light the electrons are supplied too rapidly, the silver ions do not have time to reach the sensitivity specks by diffusion through the crystal, and some of the electrons are repelled from the highly charged sensitivity specks before they can be neutralized. Much light has been thrown on the nature of the reciprocity failure by a study of the formation of the image at different temperatures.

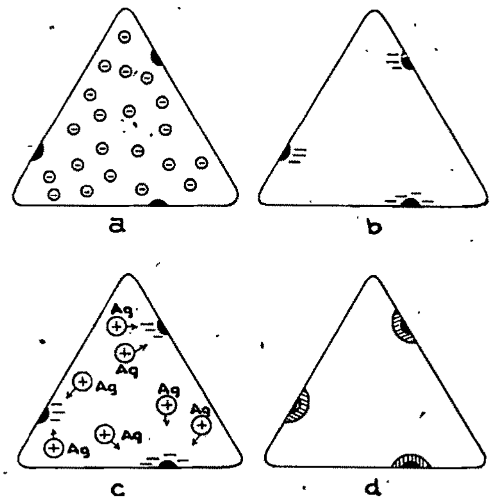

Fig. 2. ACTION OF LIGHT UPON A SILVER BROMIDE CRYSTAL. (*a*) LIBERATION OF ELECTRONS INTO THE CONDUCTING LEVEL. (*b*) CHARGING OF THE SENSITIVITY SPECKS BY THE LIBERATED ELECTRONS. (*c*) MIGRATION OF SILVER IONS TO THE CHARGED SPECKS. (*d*) DEPOSITION OF SILVER ON THE SPECKS TO FORM THE LATENT IMAGE.

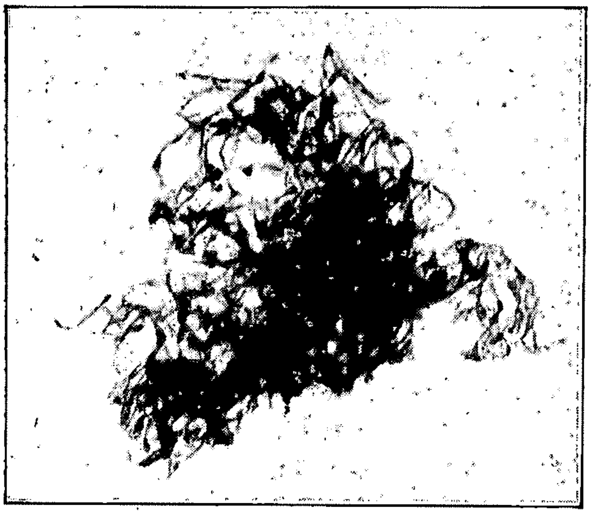

Fig. 3. ELECTRON MICROGRAPH OF A GRAIN OF DEVELOPED SILVER. ×50,000.

The metallic silver deposited at the sensitivity speck and forming a nucleus which facilitates development is what has been known in photography from the earliest days as the 'latent image'. There has been much discussion as to the nature of the latent image, but there is now no question that it consists of metallic silver concentrated at local points in the silver bromide crystal. If the silver bromide is exposed to large amounts of light, a visible discoloration takes place, and this undoubtedly consists of metallic silver. This can be shown by the use of the X-rays in the ordinary crystal structure analysis, when characteristic rings of silver crystals are obtained, and also by the examination of the image by means of the electron microscope, when it can be seen to consist of crystals of silver. Inasmuch as the visible image produced by long exposure to light consists certainly of metallic silver, the latent image produced by short exposure is almost certainly of the same nature.

The mechanism of photographic development has always been very obscure. The general theories as to the nature of development until quite recently were those which conceived it as being similar to crystallization from a supersaturated solution of metallic silver. In the absence of nuclei, deposition of silver would be delayed, and this would check further solution of the silver bromide. In the presence of a latent image nucleus, deposition of silver is facilitated and the solution, reduction and deposition of the silver bromide continues until the crystal is converted into metallic silver. There are many physico-chemical difficulties in this mechanism, but it would undoubtedly have continued as a possible explanation of development had it not been for the evidence recently supplied by the electron microscope as to the form of the silver produced in development.

The silver grains of the developed image are very small and the microscope is unable to distinguish any appreciable structure in them, so that in spite of some suggestions that the silver might be formed as filaments, the general view was that the developed silver grain was a spongy mass of silver crystals somewhat resembling a lump of coke. When developed silver was examined with the electron microscope, however, it was at once seen that the silver grain is a tangled mass of ribbon-like filaments looking very much like a mass of seaweed (Fig. 3). This is not only very important for the light that it throws on the actual structure of the developed image, but also it at once becomes necessary to account for the production of such an unusual form of silver in the development of the silver bromide. Clearly, the supersaturation theory of development will not do at all. It might be thought that the filaments are formed in cracks in the crystal, but this was disposed of by an examination of the very small crystals of so-called 'Lippmann emulsions', crystals too small to be seen in a microscope. With the electron microscope, these appear as normal silver bromide crystals, but when they are developed, each of them turns into a single filament of silver, these filaments being much longer than the diameter of the crystal from which they were formed. The impression, therefore, becomes overwhelming that the silver filament is formed by ejection from the silver bromide crystal. It is squirted out during the process of development from the solid crystal, and the picture we form of the development reaction is that the reducing ions of the developing agent attack the silver bromide crystal, and in some way the initiation of the formation of metallic silver is facilitated by the presence of the latent image speck.

The mechanism for this is supplied if we consider the potential at the surface of the silver bromide. The surface of the silver bromide grain itself has an excess of bromide ions, which give rise to a negatively charged surface. However, just outside this negative charge, a positive layer of potassium ions must be present to neutralize the negative charge. Without such a neutralizing layer of positive ions, it would be impossible for the surface of the silver bromide grain to be covered with negative bromide ions, since the amount of such a charge in so small a region would give rise to explosive forces. A double-charge layer, consisting of negative bromine ions on the grain and positive potassium ions in the gelatin just outside, may be considered to exist around the surface of each silver bromide grain (Fig. 4). Grains with such a double layer (in a solution) would move under an electric field as negatively charged bodies, since the negatively charged grain would be forced in one direction by the field, and the surrounding movable positive-ion layer in the opposite direction; but since at any point in the liquid there would be positive ions to form the surrounding positive shell, the

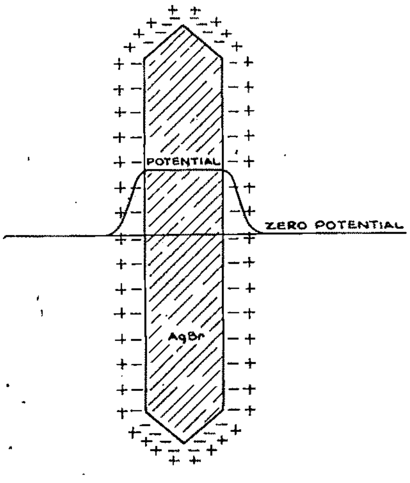

Fig. 4. DISTRIBUTION DIAGRAM OF THE POTENTIAL AND CHARGE OF A SILVER BROMIDE CRYSTAL.

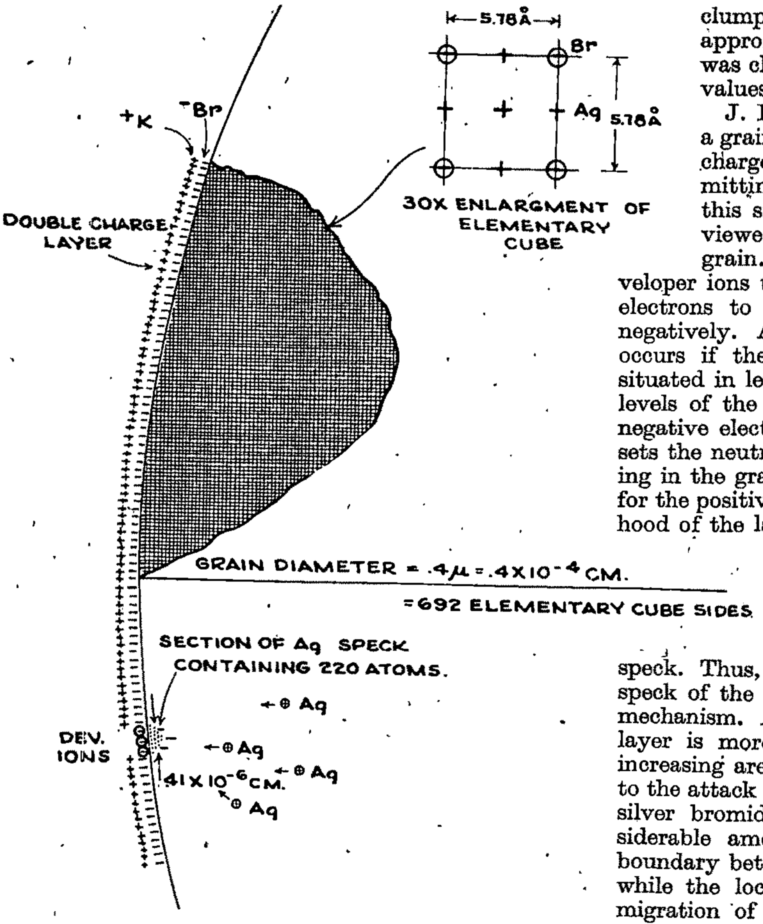
5.78Å
Br
+
Ag
5.78Å
30X ENLARGEMENT OF ELEMENTARY CUBE
+K
⁻Br
DOUBLE CHARGE LAYER
GRAIN DIAMETER = .4μ = .4X10⁻⁴ CM.
=692 ELEMENTARY CUBE SIDES
SECTION OF Ag SPECK CONTAINING 220 ATOMS.
⊕ Ag
DEV. IONS
⊕ Ag
.41X10⁻⁶CM.
⊕ Ag
⊕ Ag

Fig. 5. DIAGRAM SHOWING A LATENT IMAGE SPECK IN A SILVER BROMIDE CRYSTAL ATTACKED BY A DEVELOPER.

double-charge layer would be maintained. That the surface charges on the particles and surrounding charge layers do neutralize each other in the manner outlined is proved by the fact that the colloidal suspension does not possess a net charge of either sign but is neutral as a whole.

It may be assumed that a grain, owing to its double-charge layer, behaves toward outside charges and also those located inside the grain as a neutral body. An electron placed inside such a double-charge layer would experience no force nor, in the same way, would an electron placed outside such a double layer. However, there is a marked difference in potential between the inside and outside of the grain, and the total jump in this potential occurs in the region between the two charge layers. The potential gradient between these charge layers accordingly gives rise to a strong electrical force between the layers, and an electron placed between them would experience a force toward the outside. It is considered that the double-charge layer acts in this way as an effective potential barrier to the entrance of an electron into the silver bromide grain of the emulsion and prevents the developer from attacking the grain.

The conditions existing in the exposed grain containing a latent image silver speck may be seen in Fig. 5. This shows a greatly enlarged scale model of a charged grain surface with a clump of silver atoms on the surface, which is supposed to represent the latent image produced by exposure to light. The clump shown includes 220 atoms, with approximately the correct spacing. This size was chosen as representing a fair mean of the values given by various workers.

J. H. Webb assumes that development of a grain is initiated by the break in the double-charge layer caused by the silver speck, permitting the negative developer ions to reach this silver speck. The latent image speck is viewed as an electrode penetrating into the grain. The tendency on the part of the developer ions to release electrons to the silver causes electrons to pass to the electrode and charge it negatively. As explained by Gurney and Mott, this occurs if the electrons of the developer ions are situated in levels above the highest occupied energy levels of the silver metal. The penetration of this negative electrode into the silver bromide grain upsets the neutral electrical condition previously existing in the grain, and there arises an attractive force for the positively charged silver ions in the neighbourhood of the latent-image speck.

Positive silver ions always exist in the crystal lattice owing to temperature motion, and these diffuse to the speck under the attraction of the negative charge there and enlarge the silver speck. Thus, it is supposed that the original silver speck of the latent image continues to grow by this mechanism. As this proceeds, the protective double layer is more and more ruptured, and a rapidly increasing area of the silver halide grain is exposed to the attack of the developer. Since the reduction of silver bromide by a developer is exothermic, considerable amounts of energy are liberated at the boundary between the silver and the silver bromide, while the local rise in temperature facilitates the migration of silver ions, so that the metallic silver is extruded as a filament.

The process of development itself involves certain requirements as to absorption and catalysis of the development reaction, which explain why one substance is a developer and another reducing agent having approximately the same reduction potential is not a developer. Much work remains to be done on the chemical reactions involved in development, but the knowledge which has recently become available as to the formation and nature of the latent image and its function in promoting the development of the silver halide grain has enabled us to form a much clearer picture of the phenomena of the photographic process than was possible previously.

EFFICIENCY AND OUTPUT IN AGRICULTURAL SYSTEMS*

By Prof. A. W. ASHBY
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THE measurement of outputs of agricultural systems and their valuation are always a complex proceeding, and the results of any methods of measurement and valuation which have been used up to the present time are to some extent indefinite. Outputs vary in their physical and biochemical characteristics, and in their human uses and values. The only common measure of outputs of varied characters is their

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[*] Excerpts from a paper read before the Royal Society of Arts on November 11.

money value at any given time. Relative prices of one product and another vary from time to time, and therefore the values of outputs of given quantities of products also vary. A system or type of farming which may be shown to be efficient at one period may prove to be relatively inefficient a short time later, due solely to changes which have occurred in markets.

In any economic and social system which is subject to major changes, adaptability to changes in markets for produce, in industrial production or commercial offers of the raw materials used and usable in agriculture, in industrial production of agricultural equipment, in supply and costs of human labour, must always be a test of farming efficiency. It may, indeed, be the acid test from which there is no hope of anything except a very temporary escape. There is scarcely any major change in the economic and social institutions and conditions of a nation which does not, sooner or later, affect forms of organization for agricultural production and their results.

A quarter of a century ago many essays were made to judge agricultural systems on their outputs of food values—in carbohydrates, fats, and proteins—in the common measure of calories. But modern knowledge of nutrition, by adding vitamins and minerals to the elements expected in food supplies, has severely qualified these tests. There is no common measure which can be applied to all the food values of the products of any two or more agricultural systems.

But even when we thought we were able to measure and value agricultural outputs in physical and biochemical terms, we were quite unable to measure inputs in these terms, and therefore were unable to judge the efficiencies of systems of production. The 'calorie' test was usually only quoted per acre of land, which itself is more a measure of superficial area than of productive capacity, and any other test was rare. A simple illustration of this test shows its weakness.

The order of yields of calories and of protein per acre, of the following crops, in human use of the main products and of the secondary products of their by-products is :

	Calories per acre (order)	Protein per acre (order)
Sugar Beet	1	3
Potatoes	2	1
Wheat	3	2

While wheat and pig-meat produced by the offals give less than 45 per cent of the yield of calories obtained from sugar in sugar-beet and milk from tops, they give nearly three times the protein yield. But when the test of production per man-hour of labour is applied the order is entirely changed :

	Calories per man-hour	Protein per man-hour
Sugar Beet	3	3
Potatoes	2	2
Wheat	1	1

Wheat gives much the largest return of energy per unit of manual labour—nearly three times the return of protein when compared with potatoes, and about eight times the return of protein when compared with sugar-beet.

We may, indeed we must, occasionally apply the physical and biochemical measures to agricultural outputs in relation to human food requirements or supplies. But they are only crude tests of efficiency in feeding the nation. They are not tests of efficiency in production.

Every nation at any time, and particularly in war-time, must seek to make the optimum use of each and all its resources ; and the maximum use of land, maximum production per acre, tends to waste human energy everywhere. It nearly always wastes sweat, and not uncommonly blood and tears. A nation which has a very dense population, or a dense population tending to increase, and few resources other than its surface soil, may have no option but to seek maximum use of land, and highest possible production, but such a nation is to be pitied rather than envied. Or, in these days of close international relationships, we should say : pitied and assisted to find other outlets or uses for labour.

The general principle is that each nation will determine its standard of production per acre of land in relation to two main conditions : (1) the existence of other resources or means of useful employment of population ; (2) the standard of remuneration and of living established for workers in industries other than agriculture. When full examination is made of the economic and social conditions of nations with high density of agricultural population and high production per acre, it will be found that they adopt these conditions of necessity rather than choice. If they had other resources on which to use labour, they would modify their agricultural systems.

Efficiency, whether of motor-cars, of cows, or of crop-acres, is always measured by the ratio of output to inputs. Outputs are the results of inputs, with some factors, such as weather, which may be beyond the producer's control or even influence. Inputs are determined by the technical knowledge and the capital resources of the farmer and according to his judgment of the money costs and the money values of the expected result in outputs. Every single input may be applied with different degrees of economy and efficiency.

The main inputs are land, human labour—manual and managerial—and capital. But capital takes many concrete forms—in live and dead farming stock and materials. If we wish to apply even simple tests of efficiency of farming systems we must test production (*a*) per unit of land, (*b*) per unit of labour, (*c*) per unit of capital. We must also test by the best combination of measures of these inputs that we can find. For this purpose each has to be valued and measured in money.

The productive capacity of land or farms in Great Britain is far better measured by money values as rentals than by superficial area. The productive capacity of two acres in different districts may vary as much as 100 : 1 and commonly varies as much as 25 : 1. Rental values tend to represent and to equalize measures of productive capacity. There is no other common measure of all the geophysical conditions which influence the productive capacities of different units of land as such.

The technical conditions of choice and application of some of the embodiments of capital, both fixed and circulating, are too varied for general discussion. But some conditions may be indicated. The efficiency of power sources and of implements and machinery has been rising. It appears that the input of feed required to produce a gallon of milk has fallen by about one sixth in this century because of selection of breeds, strains, and individual animals, and greater knowledge and better practices in feeding. The feed required to produce a given weight of mutton or lamb, and the time and probably the feed required to produce a 10-cwt. fat bullock, have also been reduced.

The amount of feed required to produce a dozen eggs has been reduced by some 12–15 per cent. There is also evidence of rising efficiency in crop production.

The best simple measure of the general rise of efficiency is found in the output per man, which has probably risen about 70 per cent in the last seventy years. From 1925 to 1939 the increase was very rapid. Different criteria of efficiency may be applied by interested parties. If agriculturists as a community have to apply any single standard to production they will judge it by the net output per man (gross output less cost of raw materials and depreciation of equipment), for it is this which determines the possibilities of their standards of remuneration and of living. Having set a high standard of output per man, each class can bargain for its distribution with the assistance of any social forces they can draw to their aid. But with a low standard of output the standard of remuneration of one or more of the classes, and possibly all, must be low.

The general practice seems to have been to make international comparisons mainly in terms of yields or outputs per acre. But recently there has been a change, and other tests have been applied. On the information now available, it appears that Great Britain will take different positions in an international order of productivity according to the test applied. In a list of twelve countries—New Zealand, Australia, Great Britain, U.S.A., Denmark, Canada, The Netherlands, Belgium, Switzerland, France, Germany, Eire—the position of Great Britain is : (1) value of output per acre, seventh ; (2) persons fed per acre (on cash value basis), sixth ; (3) persons fed per worker, third (excelled only by Australia and New Zealand) ; (4) value of output per worker, third (again excelled only by New Zealand and Australia). In a test with seven European countries—Great Britain, Germany, France, Denmark, Belgium, The Netherlands, and Switzerland—the position of Great Britain is : (1) value of gross and net output per acre, seventh ; (2) value of output per worker, first ; (3) average income per whole-time person engaged, almost certainly first.

But in case there is a tendency still to judge yields or outputs per unit of superficial area of land, that is, per acre, it may be pointed out that among the seven European countries, Great Britain is second only to Denmark in gross output per pound sterling annual (rental) values, and second only to France on net output per pound sterling annual (rental) values when a standard rate of interest is applied to capital values of land in each country. The rate of interest on capital values represented by gross rents or prevailing rates of interest on mortgages is higher in Great Britain than in any of the European countries listed. Measuring gross and net outputs against annual values of land as determined by the prevailing interest rate in each country, which varies between about 2·2 per cent in Belgium and about 5 per cent in Great Britain, this country stands fourth in the list.

If Great Britain wishes to retain an agricultural population, which will be satisfied and satisfactory from either economic or social points of view, it will continue to be necessary to maintain a high standard of net output per worker, and all other standards have to be fitted to this condition. Even in war-time we have to make the optimum use of labour ; we cannot afford to waste labour on unproductive land ; we must use our labour where it will be most productive of the supplies of which the nation has the greatest need.

The nation will judge by the quantities and qualities of products offered for human use and consumption in relation to its requirements, normally expressed through the markets, but in war-time expressed through the administrative organs of the State (Ministries of Agriculture, Food and Supply). Beyond this the nation has never had any clear criteria. The interested but poorly informed public has many and often conflicting criteria. It wants reasonably cheap food, maximum employment of labour, maximum production from the land, more small holdings, higher if not maximum wages and better housing for farm workers. It wants more wheat for national defence, more milk and vegetables for health, more eggs and more and higher quality meats to stimulate appetites and to meet needs due to changes in industrial work, urban living, and standards of real incomes.

Specific tests are applicable for special purposes in certain circumstances. The agricultural system of each country is more or less fitted to its general economic and social conditions. The conditions established in one country are not necessarily to be sought by any other, and the standards applied in one country are not likely to have any real validity in any other, unless the general economic and social conditions are similar in both.

Perhaps the most acute controversy about standards of production and efficiency in the future will turn on the efficiency of large farms. Past studies of the smaller and larger farms in Great Britain have usually shown that the smaller farms had the higher outputs per acre and the lower outputs per man. But in any discussion of this problem it must be remembered that few of the large agricultural enterprises in the country have been organized on unitary holdings, and also that there is no public information on the details of organization, inputs and outputs of the best of the large enterprises in Great Britain. Before any firm judgment can be made on the relative economic and social results of the largest, the medium and the small enterprises, we need much more information on the largest enterprises. At present information is practically limited to the small and medium-sized businesses.

A further caveat must also be entered. Even if it were proved that the results of the larger enterprises now in existence are not any better than those of the medium-sized or other groups, that would not prove that large unitary enterprises could not be designed, organized and operated to yield highly satisfactory results.

GEOLOGICAL MAKING OF INDIA

MR. D. N. WADIA, author of the well-known "Geology of India for Students", retired from the Geological Survey of India in 1938, and shortly after took up the appointment of mineralogist to the Government of Ceylon. He was president of the Geological Section of the Indian Science Congress at its jubilee session in Calcutta in 1938, and became general president of the whole Congress at the twenty-ninth session held this last January at Baroda ; he is the third geologist to fill this position. During his Indian service Mr. Wadia was engaged mainly in the study and mapping of the post-Archæan folded formations of north-western India, including Kashmir. In his present service, in Ceylon, he has been called upon to study the rocks at the other end of the geological scale, forming the Archæan basement. This exceptional diversity of opportunity has enabled him in his presidential address to the Indian Science Congress (Proc. 29th Ind. Sci. Cong., Part II, 3–23; 1942) to discuss with wide experience the "Making of India", in which he makes particular use of data derived from Ceylon, which, of course, is only a detached fragment of the Peninsula of India.

Mr. Wadia emphasizes the well-known general distinction between (1) the geologically speaking, recently folded extra-peninsular area of India, comprising the mountain festoons of Baluchistan and the North-West Frontier on the west, of the Himalaya to the north, and of the Assam-Burma ranges to the east; and (2) the geologically ancient and stable Peninsula, with its Archæan basement, superposed Purana and Gondwana sediments, and Deccan Trap basalt flows, and the absence of any serious folding movements since pre-Cambrian times. Such mountains as now exist in the Peninsula of India are either deeply eroded remnants of pre-Cambrian ranges, such as the Aravallis and the Eastern Ghats, probably (in the reviewer's opinion) re-elevated, or are plateau mountains due to denudation, with block uplift and depression, as in the Deccan Trap section of the Western Ghats.

In the extra-peninsular area, compressive earth forces still prevail, as instanced by the frequency of serious earthquakes; while in the Peninsula tensional forces with vertical uplift and depression have long prevailed, and serious earthquakes no longer occur. This essential difference between the extra-peninsular and the peninsular areas of India was noticed by W. T. Blanford, in the first edition of the "Manual of the Geology of India", so long ago as 1879, and was recently emphasized by myself (*Rec. Geol. Sur. India*, 62, 408; 1930). As Mr. Wadia points out, this fundamental difference between the two main portions of the Indian sub-continent is due to the fact that it is composed of two crust-blocks of totally different history, namely, the Archæan shield of the Peninsula, which is a fragment of Gondwanaland; and the folded belt of the Himalaya representing the Tethys, which by their interaction have produced the Indo-Gangetic plains.

In Ceylon, the whole island is occupied by an Archæan crystalline terrane, except for Miocene rocks occurring mainly as a fringe on the north-western edge, and a minute occurrence of Jurassic rocks. The central portion of the island is mountainous, rising to 8,292 ft. in Pedrotallagalla. Three well-marked terraces or peneplains have been described by Prof. F. D. Adams, and are recognized by Mr. Wadia. "These three terraces rise from the sea in two sharply cut steps or escarpments, the lower step about 1,000 feet above the coastal peneplain (which is very nearly a plain of marine denudation) and the second step 3,000–4,000 feet above the latter to the third and highest peneplain" (p. 14). These escarpments are characterized by numerous waterfalls.

There are two possible explanations of these terraces. They may represent successive levels of denudation, in which case the lowest terrace is the youngest, and all that is required to explain this peculiarity in the orography of Ceylon is successive uplifts of the island as a whole, the mural scarps being due to the effects of differential erosion on beds of different powers of resistance. Or the terraces may be due to selective block uplift, and the mural scarps represent eroded fault scarps. The coastal terrace is then the oldest, and the mountain centre of the island the region of latest uplift. Adams, in his study of the geology of Ceylon (*Canadian J. Research*, 1, 425–465, 467–511; 1929), adopts the former explanation, and Mr. J. S. Coates, who was Mr. Wadia's predecessor as Government mineralogist, does not disagree with Adams in his "Geology of Ceylon" (*Ceylon J. Sci.*, **19**, Sect. B, Part 2, 101–186; 1935); nor does Coates's geological map, which is admittedly only a sketch map, show any necessity for block faulting. Mr. Wadia, in his address, discusses only the second possibility and states: "The field geological work so far carried out in this area indicates, beyond doubt, that the Ceylon mountains are not the undenuded passive remnants left out of an old table-land, but have been 'created' by positive earth-movements, lifting them vertically in two intermittent, widely separated stages". In his view the second peneplain was elevated in post-Jurassic times, and the uppermost and central terrace in late Tertiary times.

In the absence of the evidence upon which Mr. Wadia bases his belief in selective block faulting, it is difficult for the reader to judge between these two possibilities. Adams's explanation seems so reasonable that the reader will probably prefer to follow him until Mr. Wadia produces his evidence, which he has deferred to an occasion more suitable than an address to a general audience. Should Mr. Wadia's detailed account carry conviction, then the credit for establishing this hypothesis of selective block-uplift to Ceylon will belong to him.

In his general discussion of the making of India, Mr. Wadia raises many points upon which there is scope for difference of opinion; lack of space prevents reference to them all. It is necessary, however, to demur to two passages in particular, namely, that (p. 9) which speaks of the "unpuckered and generally horizontally bedded rocks" of the peninsular crust-block of India, and the statement that Mount Everest is built of "this axial granite core". Many of the Archæan gneisses and schists of the Peninsula are as contorted and crumpled as any in the Himalaya; while Mount Everest has been shown by Odell and Wager to be composed largely of metamorphosed sedimentary rocks.

In the first part of his address, devoted to general matters, Mr. Wadia discusses the interactions of science and industry in India, and also the charge against science of "helping with its inventions and discoveries man's lower instincts and lust for power, possession and aggrandizement". This misuse of science is, of course, not due to the scientific man as such, and to check such perversion Mr. Wadia states (p. 5) that "it is time the hierarchy of pure science asserted its patent rights on the common pool of strategic science and, backed by its 1½ centuries of resolute strivings for the betterment of mankind, claim a determining share in the governments of the world. An international directorate of scientists, containing a due proportion of economists, engineers and industrialists, will, by adopting the technique and temper of science, govern the countries of the world better than the chancellors, diplomats and politicians who for the past 5,000 years have failed to bring harmony in human relations, but have signally succeeded in making history one record of recurrent wars." L. L. FERMOR.

MECHANISMS OF VISION

Visual Mechanisms

Edited by Prof. Heinrich Kluver. (Biological Symposia, Vol. 7.) Pp. viii+322. (Lancaster, Pa.: The Jacques Cattell Press, 1942.) n.p.

THIS volume is the outcome of a symposium on "Visual Mechanisms" organized in September 1941 for the celebrations of the fiftieth anniversary of the University of Chicago. It is in twelve chapters, each written by specialists engaged in research on particular aspects of vision and each dealing with the advances and outstanding problems in a special field. With such a composition it might well have become no more than a series of disconnected reviews, but the authors and editor have made it into something which can be read straight through with pleasure by anyone interested in vision. Careful arrangement of the subject-matter is partly responsible, for we are led by easy stages from the material to the mental, from the photochemical reactions of the retina to the problems of visual recognition and learning. Thus the first chapter is by Selig Hecht, written with his usual lucidity, on the number of quanta needed for visual sensation. The chemistry of the visual pigments is dealt with by A. C. Krause and George Wald, there is a middle section on the activities of the visual pathways as they are revealed by electrophysiological techniques, and this leads up to the discussions by Lashley and Klüver on the way in which visual stimuli can be supposed to determine behaviour.

The book is a record of rapid progress made in the last few years, mainly along lines opened up by new techniques of physics and chemistry. The lines of advance were often unexpected and some of the classical problems of vision are not much nearer solution. There is no chapter on colour vision, for example, and probably there would not be much excuse for one, although Hartline and Granit have added significant data. But to compensate there is a valuable discussion of the factors determining visual acuity by Marshall and Talbot, based on the new electro-physiological methods. One of the basic (but seldom discussed) problems of vision is how we see, sharply defined, a straight line the geometrical image of which subtends in width only a small fraction of a retinal receptor. Marshall and Talbot have mapped the visual cortex in monkeys and have found that for the fovea the pathway from each cone expands on its way to the striate area, giving probably a direct connexion with a hundred cortical cells apart from any spread due to cross connexions at different levels. Thus the cortical mosaic has a much finer grain than the retinal; and they show that for a variety of reasons it is the cortical mosaic and not the retinal which decides the acuity of vision, the retinal mosaic being discounted by eye movements as well as by diffraction, while the cortical contrasts are intensified in a way which restores the sharpness of outline. In another chapter Bartley considers brightness discrimination from the same angle. Neither of these contributions makes easy reading, but arguments about neurone systems must always suffer from the complexity of the events with which they deal. Both chapters are certainly worth study as evidence that the analysis of activity in the units of the nervous system has already given place to attempts at synthesis, to the formulation of principles governing the distribution of activity in large groups of interconnected units. In the brain the messages from sense organs are not projected on a blank surface, but on one with a constantly changing activity of its own. We can begin to see what sort of interactions can occur and how the whole field may influence what happens in a limited arrival area: in fact the gap between the nerve impulses of the physiologist and the total configurations of the psychologist seems no longer immeasurably wide.

The two psychologists whose chapters end the book have never treated the gap between physiological and psychological aspects as if it were too wide to be contemplated with decency. Lashley has been concerned with it throughout his work and has made it far less formidable by defining the main obstacles. In this volume he deals particularly with the problem of learning and of 'stimulus equivalence'. What sort of physiological mechanism can explain our recognition of the letter A whenever we meet it? What we recognize is not the stimulation of certain neurones which have been sensitized by repeated use, for the neurones will vary with the size of the letter and its position in the visual field. Lashley rejects various theories but thinks that reverberating circuits in the cortex and interference patterns offer a more hopeful prospect. We must wait and see: meanwhile Klüver's article shows the fallacies of assuming that animals must see things as we do, and shows the careful analysis of behaviour which is essential before we can argue from the monkey to man.

Klüver rightly stresses some of the dangers of the comparative method when we are dealing with the visual system as a whole, but there is no doubt of its value when we are concerned only with the receptor apparatus. The descriptions of the anatomy of the retina by Walls and Polyak illustrate this and so do the chapters on the chemistry of the visual pigments. Wald's deals particularly with the relation of rhodopsin to vitamin A (a relation which Krause treats with some reserve), and the zoologist will be specially interested in his account of porphyropsin, the pigment in the eyes of freshwater fish, related to A_2 as rhodopsin is related to A_1, and of the rhodopsin–A_1 system in molluscs and arthropods.

The volume is worthy of the notable occasion for which it was designed. Though the War may limit its circulation we are deeply indebted to all who have taken part in it, for they have given us a welcome reminder of some of the fundamental problems of science. E. D. ADRIAN.

TEMPERATURE CONTROL

Temperature Control

By A. J. Ansley. Pp. viii+126+6 plates. (London: Chapman and Hall, Ltd., 1942.) 13*s*. 6*d*. net.

ANY regular reader of a journal devoted to physics, or to scientific instruments, or to chemistry or to industrial chemistry, will find several articles each year in which a thermostat or controlled-temperature bath is described. In the view of its author, each of these new designs is superior to any of the old ones, and in fact they usually incorporate improvements, and are usually particularly suited to the problem in hand. Given then this vast mass of literature, it is certain that an investigator confronted with the problem of building a thermostat system for himself will find it difficult to make a choice among the various systems unless he can have guidance from someone more experienced.

It is to meet the needs of such people, as well as of general students, that Mr. Ansley has written this book on temperature control, and no doubt it will be helpful to many. It deals, rather shortly, with all the main types (expansion of liquids, expansion of solids, vapour-pressure type, and so on) and frequently gives practical hints of great value. Nevertheless, it cannot be unreservedly recommended. The theoretical background is often given in a confusing manner, almost as though the author did not understand it himself, and there is in many cases an apparently deliberate departure from any logical order. Thus, on the first page, we find a section devoted to "Control Unit Terms", the first of which is "The Differential". Instead of being told at once what this is, we are informed that it "is most conveniently provided by immersing the apparatus . . . in a bath . . .". The next term, "Hunting", is explained in a way that gives it a different meaning from that usually associated with the word, and goes on (still under the same heading) to "The points to be remembered in control design are : . . .". Again, on p. 5, there is an explanation of vapour-pressure instruments which seems to imply, wrongly, that the pressure of the vapour depends on the size of the bulb. The function of the cone in a sulphur bath is not protection of metal against attack by sulphur, but to act as a radiation shield. The hydrogen in a barretter is introduced on account of its thermal conductivity and not primarily to prevent oxidation.

In addition to these major slips, there are far too many minor ones. Constantan is consistently spelled 'constantin', we are advised to use leads of 2 sq. cm. cross-section in thermocouples, the boiling point of sulphur is given on p. 29 as 445·5° and on p. 10 (where it is called the melting point) as 444·6°, the true value being 444·6°. In the table of coefficients of expansion, it is surprising to find that invar, with a higher coefficient than iron or copper, has been selected as typical.

Finally, it would be unfair to scientific workers in general if we did not point out that the grammar and style are much worse than we expect or are satisfied with. In this respect, as with the last-mentioned error and with the placing of a diagram upside down, the author has been badly served by his proof readers. They should have noticed some of the many occasions where a subject fails to agree in number with its verb, and they should have pointed out, when the author wrote " . . . it is feasible to suggest that . . ." that it is *feasible* to suggest anything whatever. They could, too, have saved him from many clumsy sentences ; for example, "This oxide not only increases the contact resistance, but renders renewal frequently or cleansing of the mercury essential. Various attempts have been made to minimize this defect by providing a protective film of oil, such as glycerine for the mercury, but after some period of use it will not be found to have improved the control".

No doubt the book has been written in difficult circumstances, and this explains many of the blemishes, but the fact remains that the book is not as good as we could have expected from this writer. However wholesome the diet, our attention is distracted from its goodness, and our appetite spoiled, by the unattractive way in which the dish is served.

J. H. AWBERY.

WEATHER STUDY IN THE UNITED STATES

Weather Elements

A Text in Elementary Meteorology. By Prof. Thomas A. Blair. (Prentice-Hall Geography Series.) Revised edition. Pp. xvii+401. (New York : Prentice-Hall, Inc., 1942.) 5 dollars.

JUDGING by the fact that this book has been reprinted five times since its first publication in April 1937, and has now been revised, it has proved very popular in the United States. The public interest in meteorology is probably much greater there than in Great Britain ; for one thing, the atmospheric phenomena are often more violent, culminating in disastrous tornadoes, floods or droughts, and the more specialized agriculture is so organized that favourable or unfavourable weather may make the difference between wealth and comparative poverty to a large agricultural population. In England our famous 'samples' are more easily balanced out by the more diversified farming. Secondly, in recent years the rapid growth of civil aviation has given many people an interest, amateur or professional, in the weather. Finally, the average American appears to be more addicted to the accumulation of varied knowledge than his equivalent in Great Britain ; he is more ready to spend money on relatively expensive books, but in consequence he prefers a book which can be absorbed quickly and does not call for prolonged and intensive study.

Blair's "Weather Elements" meets all these needs admirably. It is attractively got up ; it is full of interesting information reduced to a few lucid paragraphs on each subject ; there are plenty of illustrations including some excellent photographs, and it is very easy to read. The intelligent member of the public with little physics and no mathematics will find it ideal. For the serious meteorologist it is less satisfying, for though it is very good so far as it goes, it does not go nearly far enough.

One example will suffice. The chapter on "World Weather" contains, among others, sections on "Frequency curves" and "Correlation coefficients and regression equations". The first gives two frequency polygons, with values of the mean, median and mode, but no attempt is made to explain the two latter terms. The polygon of 65 January rainfalls at Cleveland by steps of 0·2 in. is highly irregular ; an isolated maximum at 1·40–1·59 in. is called the 'mode', but the reader is not warned that the record is too short to give such minor details any real meaning. Again : "Mathematical considerations also enable us to determine how often the rainfall will fall below or exceed any given amount". It is left at that ; standard deviation is not even mentioned. A correlation coefficient "is computed by a mathematical process which takes account of and compares the individual deviations from average of the two sets of data year by year". There is not an x or y in the book ; nothing, in fact, to break the smooth, even flow of text.

From another point of view the book is definitely written for an American public, in that there are few references to methods or events in other continents. The methods of observation described differ in many important respects from those in use in Europe ; the dry- and wet-bulb thermometers are whirled in a sling instead of being read in a screen, the rain-gauge is read with a dipping rod instead of with a measuring glass, the sunshine recorder is electrical and the cloud searchlight becomes a "ceiling light". The only barometer described is the Fortin, but the description is very sketchy and the illustration useless; the vernier is mentioned, but not described, and there is no indication of its purpose. The U.S. Weather Bureau fog scale is given, but the usual international definition of a fog is not mentioned.

The author is at his best in describing the simple physical processes of weather, and these parts of the book should be of real value to school teachers, who are also provided with a number of ready-made test questions and with several pages of monthly means of temperature and rainfall. There are a few odd statements, such as "Warm and humid air, as in a fog", and that air in crowded rooms suffers from *low* humidity. The chapter on "Climate and Man" contains a good deal of interesting material not usually found in text-books of meteorology, and the last chapter gives an excellent account of the history and activities of the U.S. Weather Bureau, especially in their application to matters like the control of floods or forest fires and the combating of frost damage, which should interest all citizens of the country. There is an excellent classified bibliography of suggestions for further reading.

C. E. P. Brooks.

FOOD AND PLANNING

Food and Planning

By Prof. J. R. Marrack. Pp. 285. (London: Victor Gollancz, Ltd., 1942.) 15*s*.

THE dictum that the scientific man should 'have no politics' is still held to-day by many men of science. It is interpreted variously: that scientific research should possess the worker, excluding all else from his mind; he should have his energies fully occupied in solving his academic problems, and the applications of the results are 'politics', and should be left to others; he would be biased in his approach to an academic problem by an active interest in the practical applications of its solution. It is true the research type of mind is rarely adapted to apply the results socially, unless the biological trend of the investigator's thought is in that direction. The acute struggle for existence of the War of 1914–18 and its post-war period led to governmental organization of the applications of science to everyday problems. The planned surveying of man and his environment increased our knowledge of *Homo sapiens*, and stimulated further investigations. Possibly the main development of science between the two wars is the realization that there is a natural and close interdigitation between the pure abstract problem and its application in industry or human life. The scientific man is not a mental eunuch, but rather a rational human being, whose work must be conducted objectively and fearlessly, and whose reasoning and experiments need to be uninfluenced by conditions of expediency or possible repercussions.

This close connexion between science and the social life of the world's population is possibly most appreciated in physiology, and particularly in regard to nutrition. Prof. J. R. Marrack in this book exemplifies the relation of the research worker to the applications in everyday life. He shows that not only have we knowledge of the nutritive needs of human beings, but also that the bulk of the world's population is by these same standards undernourished in varying degree. If we feel the welfare of human beings is important, then we can, by planning for that purpose, achieve adequate nourishment for everyone in all countries, as Sir John Orr emphasizes in the preface.

The first part of the book deals with the normal foodstuffs, their chemistry and function, and with the physiological requirements of the individual. This elementary physiology is dealt with in a manner different from that of the standard text-book. The emphasis is on the needs and response of man, rather than that of animals. The evidence is new, modern and recent, and the experimental illustrations are culled almost entirely from human experiments, surveys and international experiences. An excellent account is given of the pathological distortions, and of the problems of standards of food requirements.

The next part of the book treats of the applications of this knowledge. Beginning with details of actual peace-time consumption of food in different countries throughout the world, it follows with a clear statement of the evidence for malnutrition and impaired health arising thereby. Next there is described the food consumption in Britain and on the Continent during and after the War of 1914–18, the ill-effects arising, and the administrative steps taken to combat this bad health. The last three chapters deal with the present War, the rationing and the respective policies of Britain and Germany. Finally, Prof. Marrack plans for the future as well as for our present war-time state.

The book is long, and although comprising only 285 pages, it is in small print, and achieves fairly—and sometimes very—detailed accounts. It is written for the educated man with an elementary knowledge of general science, but is essentially non-technical and straightforward, very lucid and always understandable. It is a book that will be frequently utilized by anyone interested in the subject: it is strikingly full of new names, facts, experiments, references and views, but its utility is seriously impaired (quite apart from the war-time price of 15*s*. net) by the complete absence of a list of tables and diagrams, of an index or a bibliography. Different individuals will question different parts, the attribution of responsibility, the weighting of evidence, but this is largely a question of legitimate difference of opinion or inference.

Probably one of the most important contributions of the book is the large body of evidence—physiological, sociological, economic and political—which Prof. Marrack has collected as to the causes of defective food supplies. It is patent throughout that the stimulus of a humanitarian philosophy has incited the author to write this book and to initiate a plan which he feels will improve human welfare. But the one construction of this plan is based on an objective examination of the evidence. It is built up dispassionately and logically, because it is in the best interests of the world to have no obstacles left that prevent the fullest nutritive health. Prof. Marrack further maintains that now, while the War is being fought, is the time to begin planning. "The redeeming sanity of war is that its purpose is clear, and its methods are logically directed towards the achievement of that purpose—can we keep this sanity after the war, and use the working machinery to plan an ordered society in which the needs of the people are the prime object ?" (p. 284).

Prof. Marrack regards the world's food supply as being inadequate, because it is left to an economic system dependent upon a profit motive for its effective working. The breakdown may be in purchasing power, retail price, costs of transport, production, or governmental financial policy. So long, however, as food supply is controlled by factors other than the nutritional needs of the people, so long will that supply be liable to shortages.

Before this War, 90 per cent of the world population was in some respect short of food. The essentials of food planning include increasing the production of food. The biggest obstacles to this in different parts of the world are the small size of farms (33 per cent of farms in Japan are a quarter of an acre in size), debt on the farmer (£40 per head of population in Rumania) and backward state of agriculture (primitive instruments and methods). Planning must include regulation of amounts and type and transport of foodstuffs, and finally increased purchasing power. To attain all this with efficiency, Prof. Marrack proposes an international supreme authority with power to plan on a world scale, using the fullest resources of the globe, and with executive powers to carry its plans to fruition, so that no obstacle shall impede any individual from attaining full nutritive health.

A. ST. G. HUGGETT.

SURFACE PHYSICS AND CHEMISTRY

The Physics and Chemistry of Surfaces
By Prof. Neil Kensington Adam. Third edition. Pp. xii+436. (London: Oxford University Press, 1941.) 22*s.* 6*d.* net.

MANY branches of science have had their seeds planted some forty years ago and in the intervening period have germinated, grown and flourished to such an extent that massive trees now stand on previously bare earth. The physics and chemistry of surfaces is in this category, and the historian follows this growth first by means of a monograph and then with a text-book in which edition follows edition. Prof. N. K. Adam is universally recognized as one of the historians of this subject, and we welcome his third edition of his well-known text-book.

This volume follows the lines of his second edition, in which a few sections have been rewritten and certain important advances have been inserted in an appendix. It must be admitted that this is not a very satisfactory method of presenting an integrated view of the whole subject. Indeed, the fundamental difficulty presented to the historian goes somewhat deeper, in that subjects soon outgrow the confines of a single text-book. It would indeed be preferable to cut once and for all the Gordian knot and divide the subject into discrete sections, for example, into fluid and solid surfaces respectively. The problems of each would indeed be confined, but with difficulty, into the confines of single separate volumes.

The present edition gives an excellent account of the present state of our knowledge of the liquid surface, in which field Prof. Adam himself is a recognized authority, but many advances have been made in the study of gas films on solid surfaces as well as in understanding the mechanism of the various heterogeneous catalytic processes, more particularly those involving hydrogen, such as exchange reactions, hydrogenation, double-bond migration and ring closure in hydrocarbons, which might well have been included in an authoritative text-book.

The space which would be available if these topics were transferred to a separate volume could readily be filled by extension of certain portions of the present volume. Thus on p. 35 some thirteen lines only are devoted to the examination of films by reflected light. This method of examination, admittedly a difficult one, is a powerful method of attack, and several interesting properties of films have been revealed which might well have been included.

The general characteristics of surface films of insoluble materials can be portrayed by means of the phase rule, and the thermodynamics of the equilibrium between phases and changes of state have been shown to follow the three-dimensional prototypes. In ordinary phase changes there is a sharp transition in which the properties change discontinuously, including the area and the entropy (resulting from the latent heat). We know in three-dimensional systems that there are cases in which the change in volume and entropy are not discontinuous but merely change very rapidly within a few degrees; this is revealed by a large specific heat in the neighbourhood, but no latent heat. Such changes as are exemplified by molecular rotation in crystals or order-disorder transformation in β brass are phase changes of the second order. Dervichian, in a lengthy series of investigations, recently showed that such changes were also exhibited by monolayers. More than one page in the appendix might have been devoted to this work.

On pp. 38–39 a general description of the method of presenting the results of measurement of the phase boundary potential at liquid/air surfaces is given, and a further development of the concept of phase boundary potentials at liquid/solid and air/solid interfaces is given in Chapter 8 and the appendix thereto. Gatty's analysis of the phase boundary potential at the liquid/air surface provides us with the clearest picture of the origin of surface potential and should find a place in the introductory chapter.

It is clear that our knowledge of the structure of monolayers of macromolecules, especially of the biologically important proteins, is by no means complete. The author adopts the view that protein films are coherent. Several French investigators, on the other hand, have claimed that the vapour state can be obtained and actually measured, providing us with a method of determining the molecular weight. This clearly requires reinvestigation.

Only two and a half pages are devoted to consideration of the chemical reactions in films and the formation of complexes by the process of film penetration. The literature on this subject is now fairly extensive, and in view of the many biological implications it may be regarded as one of the most important aspects of surface chemistry, fully meriting a chapter to itself.

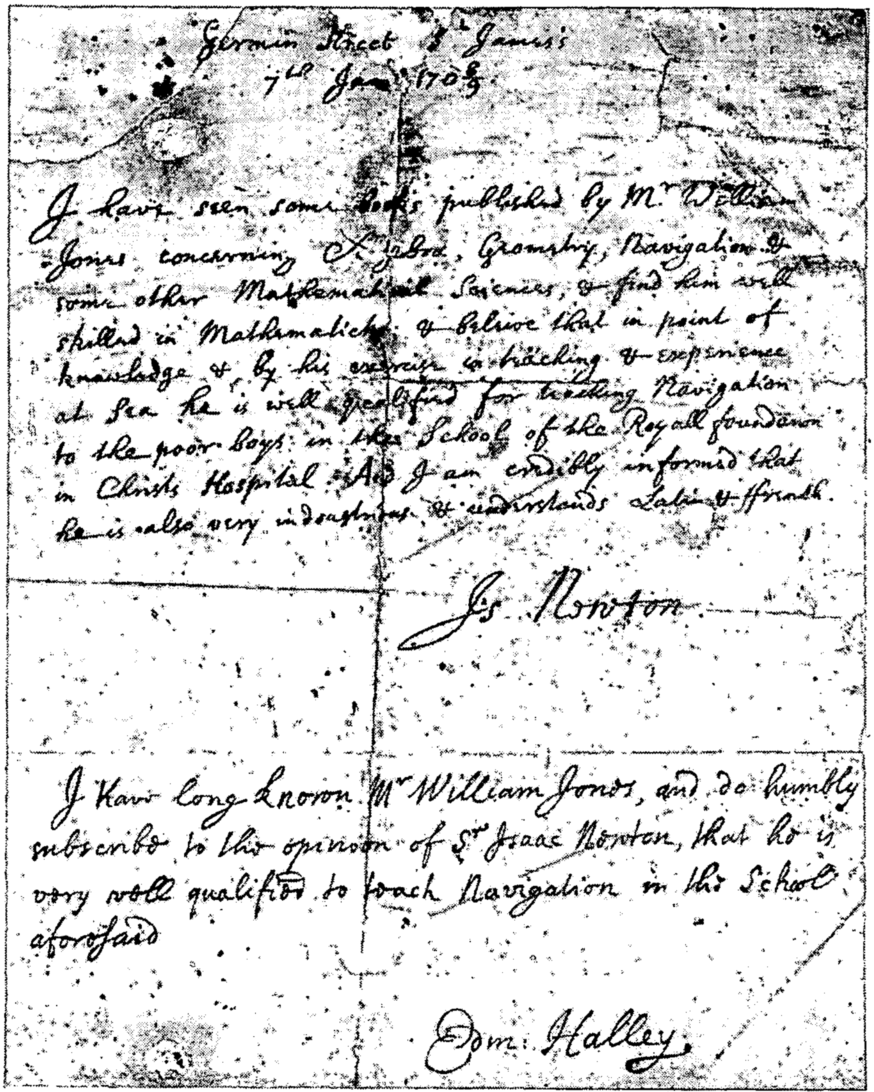
The third edition has been compiled with the author's usual care, and the topics given in the appendix have evidently been carefully selected with the view of presenting important as well as interesting developments in the field of the physical chemistry of surfaces. Scarcely any imprint of war is to be noted in the paper, binding, or printing of this, the third edition.

ERIC K. RIDEAL.

NEWS and VIEWS

Newton's Life and Works

Among the tercentenary celebrations of Newton's birthday was a meeting of the London and Home Counties Branch of the Institute of Physics held on December 9. The meeting was addressed by Dr. H. Buckley, of the National Physical Laboratory, and very appropriately was held in the Royal Institution, where a few days previously the Royal Society celebrations had taken place. Dr. Buckley's theme was "Some Historical Aspects of Newton's Work". He reviewed Newton's life in its relation to his scientific work, bringing out his interest in experimental studies and recounting the development of the papers presented, generally as the result of invitation, to the Royal Society. Speaking of the "Opticks", Dr. Buckley pointed out that, as in the "Principia", Newton develops the subject by the formal method of propositions, each followed by proofs, but whereas in the "Principia" the proofs are mathematical, in the "Opticks" they are accurate and clear descriptions of experiments. An informative account of the fate of the various editions of the "Principia" was given. As is well known, the first edition was produced at Halley's expense. It appeared in July 1687 as one small quarto volume of 500 pages bound in calf and was sold at 10*s*. to 12*s*. a copy. This sold quickly and by 1691 was difficult to obtain. A second edition appeared in 1713, produced with the assistance of Roger Cotes, the young Plumerian professor of astronomy at Cambridge; 750 copies were printed, of which 250 were sent to France and Holland. It sold in England at 15*s*. a copy, and up to 21*s*. bound in calf. Bentley, then master of Trinity College, Cambridge, bore the cost of publication



Jermin Street St James's
7th Jan 1708/9

I have seen some books published by Mr William Jones concerning Algebra, Geometry, Navigation & some other Mathematical Sciences, & find him well skilled in Mathematicks & beleive that in point of knowledge & by his exercise in teaching & experience at Sea he is well qualified for teaching Navigation to the poor boys in the School of the Royall foundation in Christs Hospital. And I am credibly informed that he is also very industrious & understands Latin & ffrench.

Is. Newton

I have long known Mr William Jones, and do humbly subscribe to the opinion of Sr Isaac Newton, that he is very well qualified to teach Navigation in the School aforesaid

Edm: Halley

A testimonial given by Newton, and subscribed by Halley, in favour of William Jones, afterwards a Fellow of the Royal Society, who was applying for a post on the staff of Christ's Hospital. By courtesy of the Royal Society.

Cotes received twelve complimentary copies, but probably he refused all other recompense. A third edition appeared in 1726, but this contained only minor alterations; it was edited by Henry Pemberton, who received £200 from Newton for his work. Pemberton is also reputed to have received £3,000 for his "A View of Sir Isaac Newton's Philosophy", which was published by subscription; the subscribers numbered some 2,400, including peers of the realm, most of the bishops, and other notables including Alexander Pope and Edward Gibbon, a remarkable tribute to the esteem in which Newton was held. Collected editions of Newton's work were published in Lausanne and Geneva in 1744 in three volumes, and in London during 1779–85, though neither is complete. It is to be hoped that steps will be taken to produce a complete edition of the works of Britain's most distinguished natural philosopher.

Sir John Russell, F.R.S.

On September 30, 1943, Sir John Russell will retire from the directorship of the Rothamsted Experimental Station, which he has held since 1912, when he succeeded the late Sir Daniel Hall. During 1907–12 he was Goldsmiths' Company soil chemist at Rothamsted. In these thirty-five years of service Sir John has been associated with striking advances in agricultural science. An early achievement was the evolution of a method—then conveniently described as partial sterilization—for restoring the fertility of rich, but 'sick', soils such as tomato and cucumber beds. A sub-station of Rothamsted was established at Cheshunt, in the centre of the glass-house industry, to deal with this and related problems; its work was so successful that it quickly became an independent research institute. During the War of 1914–18 Sir John was technical adviser to the Food Production Department. Shortly after the War, the agricultural research and advisory organization was greatly expanded by the Government and, in common with other institutes, Rothamsted enlarged its staff and its programme of research to include plant pathology and entomology as well as its traditional subjects of soil science and crop growth. Important scientific advances were made in all of these branches and Sir John attacked the double problem of testing them under varying soil conditions and agricultural systems, and of accelerating their absorption into farm practice. He increased the contacts of Rothamsted with agriculturists and farmers' organizations until the objects and work of the Station became as well known in the countryside as among men of science. Striking proof of this was given in 1934, when the experimental fields were threatened with building developments: a public appeal was issued for funds to purchase the farm, and the amount required, £35,000, was over-subscribed in less than two months.

A further development, sponsored by Sir John, was the extension of Rothamsted's activities to overseas agricultural problems. This work began in 1923 when he was invited to the Sudan to advise on agricultural developments and scientific activities. Since that date he has made extensive visits to the Dominions, India and a number of the Colonies, as well as to many foreign countries, either by direct invitation from their Governments, or as the British Government delegate. He took a leading part in the Imperial Agricultural Research Conference of 1927, as a result of which the Imperial Agricultural Research Bureaux were set up, the one for Soil Science being located at Rothamsted under his direction. In pursuance of his policy of making widely known the scientific and practical results of agricultural research, Sir John has written a number of authoritative books on agricultural science and practice. The best known is "Soil Conditions and Plant Growth", which first appeared in 1912 and is now in its seventh edition. The successive editions contain their own record of the striking advances with which his name is associated. In recent years Sir John has done much to develop the international aspects of agricultural research. But for the War, Rothamsted would have celebrated its centenary in 1943 by an international gathering. This project has been submerged by the urgent war problems and the looming difficulties of post-war agricultural reconstruction in devastated Europe. In these problems Sir John is taking an active part. He serves as adviser to the Russian Branch of the Ministry of Information, and is a member of the Inter-Allied Government Committee on Post-War Requirements.

Bicentenary of Scheele (1742-1786)

The bicentenary of the birth of the Swedish chemist Carl Wilhelm Scheele, whose recently published manuscripts were reviewed in our columns on November 7, falls on December 19. His birthplace was Stralsund, in Pomerania, then a Swedish province, but he was trained as a pharmacist in Gothenburg. Here he remained until the age of twenty-three, studying the works of Stahl, Lémery, Kunckel and Neumann and for ever experimenting. From Gothenburg he went to Malmö, then to Stockholm and Uppsala, where he met Gahn and secured the friendship of Bergmann. At last in 1775, at the age of thirty-three, he was officially appointed apothecary at the little town of Köping on the western shore of Lake Malar. His death took place at Köping on May 19, 1786, when he was only forty-three. Among a crowd of original discoveries those relating to chlorine, manganese and oxygen are the best known. His papers were printed mainly in the *Transactions* of the Royal Academy of Stockholm. Dr. Beddoes translated his "Chemical Essays" in 1786 and a reprint of this was published in 1901. This was reviewed in Nature of November 7, 1901, the reviewer remarking then, "The strict fidelity to experiment, the rare sagacity, the scrupulous and minute observation and the extraordinary experimental skill combine to make Scheele a model for all time. When we add to this the pathos of his early struggles, the simplicity of his blameless life and the nobility of his untimely death, there can be no wonder that Scheele is reckoned a hero among chemists".

University Students and Military Service

In the discussions in the House of Commons on December 9 and 10 on the National Service Bill, 1942, Mr. E. Bevin, Minister of Labour, pointed out that the measure was largely an administrative one to facilitate the calling up of young men of eighteen. The position of prospective university students was discussed by several members of the House. Mr. K. Lindsay remarked that the Bill meant the end of university life in Great Britain during the War, except for a few specialists. Mr. Harvey asked for an assurance that if an undergraduate's work was satisfactory he would be allowed to complete an academic year before being called up. Sir P. Harris said that any advance in education after the War would be impossible without a proper supply of teachers, and hat the proposed call-up would paralyse the whole educational scheme of the country.

Mr. McCorquodale, Parliamentary secretary to the Ministry of Labour, replying to the debate, said that he medical schools would decide on the basis of he first examinations which students would be granted deferment. Scientific students would be ecommended for deferment by the University Joint Recruiting Boards. The Minister of Labour had decided that he could no longer allow boys whose medical grade was sufficiently high to make them liable to serve to go up to the university to take an arts course for one year. This decision would entail he closing down at the end of the summer of the present year's university arts course with the exception of those who were medically unfit for the services. As to the question of mathematics, if a scientific student persuaded the Recruiting Board hat his course was in the interest of the prosecution f the War, he would get facilities for carrying it through. The Bill was read a third time.

Radio Research for the Services

MR. LYTTELTON, Minister of Production, said in the House of Commons on December 9, that in view f the great increase in the importance of wireless communication and radio-location during the War, the Government has set up a Radio Board as the co-ordinating body in regard to inter-Service policy, research, development and production. The Board is in general responsible to the Minister of Production, but where matters of service policy are concerned it takes its instruction from, and is responsible to, the hiefs of Staff Committee. The Minister Resident for Supply in Washington (Colonel Llewellin) acted in is personal capacity as the first chairman of the Board. On his appointment to Washington he was succeeded by the Minister of Aircraft Production, Sir Stafford Cripps, also in his personal capacity. he chairman is assisted by two deputy chairmen, he Parliamentary Secretary to the Ministry of Supply (Mr. Garro-Jones) and Prof. G. P. Thomson. he membership of the Board includes representatives of the Admiralty, War Office, Air Ministry, Ministry of Supply, Ministry of Aircraft Production, and General Post Office, as well as several special non-departmental members. Much of the work of the oard is carried out through two main working ommittees, the Production Planning and Personnel Radio Committee and the Operations and Technical adio Committee, of which Mr. Garro-Jones and Prof. Thomson are respectively chairmen.

New Light Day Bomber for the R.A.F.

RECENT reports of a day raid upon Eindhoven, olland, mention for the first time the use of the Lockheed Ventura I. The R.A.F. type is presumably development of the American machine, originally nown as Lockheed Vega 27. This model is powered by two 2,000 h.p. Pratt and Whitney Wasp 18-ylinder radial engines, and has a speed of 275 miles er hour, with a range of 1,500 miles. It carries a ew of four or five, as necessary, and has armament of two movable and two fixed guns in the nose, a Boulton and Paul gun turret on the top of the body, nd two movable guns underneath. It is probable that the improved version is superior to this in both erformance and armament. The most significant point about the aircraft is that it is a further step towards completing a range of high-performance bombers and fighters that, in total, form a team for heavy day bombing, working upon the theory of smothering the defence when attacking. The Boeing Fortresses operate at great heights, Liberators at a little less, with Venturas, Mustangs and Mosquitoes lower down, even to ground-level. The high speeds and good manœuvrability of these machines make them able to take reasonable evasive action when attacked by anti-aircraft fire, their performance is comparable with British fighters, simplifying the question of their being escorted, and even unescorted their armament and manœuvrability allow them to put up a good defence against enemy attacking fighters.

Recruitment of the Civil Service

THE sixteenth report of the Select Committee on National Expenditure, in a section dealing with the recruitment of the Civil Service, includes some account of the Appointments Department of the Ministry of Labour and National Service, created on March 1, 1942, in which the old Central and Supplementary Registers have been merged, which should be of interest to scientific workers. As a recruiting agency the Ministry's organization now also includes the Temporary Government Service Registers and the Central Register of Aliens, and in regard to the latter, the report recommends that a much more vigorous attempt should be made to keep the Central Register up to date and to find suitable employment for the persons whose names it contains. Reviewing the operation of the Central (Scientific and Technical) Register, the report comments on the relatively slight use made of this Register by industrial firms as compared with Government departments. In regard to engineering appointments, the Committee recommends that academic qualifications should not be allowed to overshadow the less easily assessable but great practical value of men who have graduated through the workshops to management level. It is also recommended that to meet the shortage of persons of managerial capacity, the Ministry of Labour should make a careful search for persons who might be up-graded above the level of their present employment.

The importance is stressed of the Ministry preparing in good time for the difficult post-war task of placing in civil employment the large numbers of men and women demobilized from the Armed Forces, and attention is also directed to the importance, as a means of remedying the shortage of technically qualified recruits in Government departments—and the remark applies equally to industry—of ensuring the most economical use of such persons after appointment. This involves a careful watch on the changing conditions of industry from the point of view of the technical help and supervision needed from the Supply departments. The report also includes a memorandum by Sir James Rae on the professional and technical staffs in Government departments which describes the work of the assessors appointed early last year. This review covers the elimination of functions not essential to the prosecution of the War, the elimination, following if necessary a relaxation of normal peace-time standards, of all work now entrusted to professionally and technically qualified staff which is not absolutely necessary for the discharge of those functions, reduction to a minimum of checking and reference to higher authority, increased collaboration between Departments with the view of avoiding overlapping of functions, a re-organization of the remaining work so as to make the minimum demands on professional qualifications, and to ensure that work not requiring such qualifications is devolved on persons less highly qualified. The report also recommends that delays in the payment of increases of salary either as increments or as the result of promotion should be eliminated, and the immediate investigation of the alleged inadequacy of salaries paid to technical officers. The Committee regards it as fundamental that there should be a reasonable relation between the salaries paid by Government and industrial firms respectively.

Agriculture in Northern Ireland

Addressing a meeting at Ballyclare, Northern Ireland, Mr. J. F. Gordon, the Northern Ireland Minister of Labour, said that during the present year the farmers of Northern Ireland have surpassed all previous records in the production of food. They have increased land cultivation by 100 per cent, and obtained an agricultural turnover during the year of £44,000,000. After feeding the people of Northern Ireland and the troops stationed there the farmers have sent about £10,000,000 worth of food, including 360,000,000 eggs, to swell the larder in Great Britain. The Northern Ireland Ministry of Agriculture has pushed ahead with a scheme of potato processing plant, and it is hoped that nine factories will be completed in time to deal with the 1942 surplus crop, converting it into potato meal for animal feeding and into potato for human consumption.

Depths of the Arctic Ocean

A note on some important Soviet flights in the Arctic is contained in the *Polar Record* of July. In March 1941 Ivan Cherevichni, and four others, flew from Moscow via Archangel, Franz Josef Land and Severnaya Zemlya to their base on Wrangel Island. Thence several flights were made to the north to investigate conditions in the least known area of the Arctic Sea. On the first flight a descent on the pack was made in lat. 81° 2′ N., long. 180° E., and for four days hydrographical observations were made. The ocean depth was 1,447 fm. The next flight was to lat. 78° N., long. 176° 40′ E., where the depth was 1,015 fm., and the third flight was to lat 78° N., long. 170° E., where the depth was 1,878 fm. In the Cherevichni triangle, made by these three stations, the depths appear to be considerably less than the single sounding of Sir Hubert Wilkins in 1927 in lat. 77° 45′ N., long. 175° W., which was 2,830 fm. These discrepancies in depths were not expected in the Arctic Ocean. The physicist in the party found the intermediate layer of warm Atlantic water at all three stations. It will be recalled that this layer, first found by Nansen, was noted by Papanin, of the Soviet drifting polar station, some years ago. It is now fair to assume that it occurs throughout the Arctic basin.

The Couvade

In the recently published September issue of *Folk-Lore*, Mr. L. F. Newman discusses the curious but widespread and ancient custom named 'couvade', which consists in the illness of the husband during his wife's pregnancy, parturition and puerperium. He classifies the theories as to its origin in thre groups according as they are held by (1) the classica school, who follow Apollonius Rhodius, Strabo Plutarch and the other early writers; (2) the historians, who base their views on authors such a Marco Polo, Bacon, Butler and others; and (3) th anthropologists, who are influenced mainly b scientific data and records from the life of the mor primitive peoples. Mr. Newman comes to the con clusion that a number of quite diverse customs hav been grouped together under the name of th 'couvade', and that many are not different types o one definite custom, but are survivals of recorde instances of separate customs and are of multipl origin.

Standardizing Electrical Instruments

In a paper read on December 3 in London befor the Institution of Electrical Engineers, Lieut.-Col. K Edgcumbe dealt with the standardization of industria electrical instruments from the aspects of performanc limits, dimensional limits and certain constructiona features facilitating interchangeability and promotin commercial manufacture, and other minor matte such as preferred terms, definitions, symbols, et Comparisons are made of the standards issued i Great Britain, the United States and Germany an by the International Electrotechnical Commissio suggestions being put forward for the extension c amendment of the pertinent specifications issued b the British Standards Institution, notably *BS*8 *BS*89 and *BS*90.

Announcements

We regret to announce the death of Sir Henr Miers, F.R.S., Waynflete professor of mineralogy i the University of Oxford during 1895–1908, princip of the University of London from 1908 until 191 and vice-chancellor of the University of Manchest and professor of crystallography during 1915–26, c December 10, aged eighty-four.

Dr. G. A. R. Kon has been appointed as the fir occupant of the University of London chair chemistry tenable at the Royal Cancer Hospital (Free which was instituted just before the outbreak of wa Dr. Kon has been a member of the staff of t Imperial College of Science and Technology sin 1925, the title of reader in organic chemistry bei conferred on him in 1935.

It is announced that the estate of Sir Jose Larmor, who died on May 19 (see Nature, June p. 631), amounts to £54,500. He made the followi bequests, among others: £3,000 to St. John's Colleg Cambridge, for annual rewards for undergraduate £3,000 to the Royal Academical Institution, Belfa to supplement scholarships; £3,000 to augme emoluments held by junior members in Northe Ireland of Queen's University, Belfast; £2,000 to t University of Cambridge to provide medical a other assistance to junior members of the Universit £1,000 each to St. John's College, Cambridge, a Magee University College, Londonderry; and £750 ea to Trinity College, Dublin, and the National Universi of Ireland for the benefit of University College, Galwa Subject to other bequests, the residue is to be us for increasing the educational bequests to St. John College, Cambridge, the Royal Belfast Academic Institution, and Queen's University, Belfast.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Discoveries by Accident

PROF. H. R. ROBINSON writes in NATURE of November 21, p. 591: "In November 1895, Röntgen discovered X-rays, largely by accident. Becquerel's discovery of radioactivity in February 1896 was largely a second accident arising out of Röntgen's discovery".

One is tempted to ask, how can it be determined whether a discovery has been made by accident? My colleague in chemistry has provided the following instance of what may legitimately be called an accidental discovery: the fact that mercury acts as a catalyst in the oxidation of naphthalene to phthalic acid by sulphuric acid was revealed by the breaking of a mercury thermometer.

In his "Theory of Light", Preston refers to Arago's discovery in 1811 of the interference of polarized light in the following terms: "Placing by chance a thin plate of mica in the path of a pencil of plane-polarised light and examining it through a doubly refracting prism he observed that both the ordinary and the extraordinary images were richly coloured. . . ." It may have been *by chance* that mica was at hand, but few would call this an accidental discovery because of the associated work and thought of the experimenter.

In the case of Röntgen, no one would gainsay that he was fortunate, lucky perhaps, in having a fluorescent substance on the table, but it may be questioned whether we should call his discovery an accident. According to Glasser, "Röntgen had taken up the work with cathode rays because he had a feeling that there were still many unsolved problems connected with them. . . ." There lay the intention to enter a new field of inquiry, but when a man makes an outstanding discovery in a subject absolutely new to him (as shown by his fifty-eight original papers prior to 1895), it is not surprising to find it attributed to accident, luck or good fortune.

With Becquerel and the discovery of radioactivity the case is rather different, for it was clearly his intention to see whether fluorescent substances emitted anything like X-rays. So the discovery was no accident, though Becquerel had wonderfully good fortune in having at hand a unique collection of uranium compounds handed down by father and grandfather; it was a family discovery.

The subject is a difficult one; for national bias can rarely be eliminated in writing of world events; we become aware in fact of the pitfalls besetting the historian. But I hope that this particular issue may be clarified, for it is a recurrent question in radiological circles: Did Röntgen really discover X-rays, and if so, was it an accident? My usual answers until now have been Yes and No.

SIDNEY RUSS.

Barnato Joel Laboratory,
Middlesex Hospital.

PROF. RUSS has quoted a passage from my *summary* of the Rutherford Memorial Lecture; in the lecture itself I went on to pay a tribute to Röntgen and to Becquerel, emphasizing in particular that there was nothing in their general attack on the problems of X-rays and of radioactivity that could be described as in any way "accidental". My only reason for mentioning at all the element of chance was that in this part of the lecture I was directing attention to the remarkable sequence of largely unrelated events which prepared, at exactly the right time, a field of work for Rutherford and a gateway for his entrance into this field.

The lecture, which occupied about an hour, had to be pruned rather drastically to reduce it to the dimensions appropriate to a printed summary. My unskilful pruning, by divorcing a passage from its context, has clearly left the impression of an opinion of Röntgen's and Becquerel's achievements which I neither held nor wished to convey. I am grateful to Prof. Russ for his letter, and for the opportunity to comment upon it, and so, I hope, to remove all traces of this false impression.

H. R. ROBINSON.

Queen Mary College
(University of London).

Retarding Effect of Ghost Formation on Absorption from Subcutaneously Implanted Tablets of Hexœstrol

IT has recently been reported[1] that when tablets of synthetic œstrogens are implanted subcutaneously into bovines, the outer or 'cortical' layer of the tablets becomes infiltrated with a structure apparently composed of relatively insoluble protein. The formation of this structure, for which the name 'ghost' was proposed, should not be confused with the phenomenon of encapsulation of the tablet within a sac of fibrous or connective tissue, which was considered by Geist *et al.*[2] to cause a considerable decrease in absorption from tablets implanted into humans. Whatever may be the effect of encapsulation, it was considered likely that ghost formation would retard absorption, and experimental evidence that this is so has now been obtained.

In connexion with investigations on lactation, the absorption (that is, loss in weight) from tablets of pure hexœstrol weighing very nearly 1,000 mgm. each, which were implanted subcutaneously into bovines for periods ranging from 10 to 105 days, has been determined. The tablets were disk-shaped, approximately 14·4 mm. in diameter, 7·8 mm. thick in the centre and 5·7 mm. thick at the edge.

Contrary to the findings of Emmens[3], Forbes[4] and others on rats, the absorption curve, though approximately linear up to 10–15 days (when about 12 per cent of the tablet had been absorbed), bends sharply at this point and thereafter pursues an approximately rectilinear course corresponding to a much-reduced absorption rate. The initial absorption rate was about 9 mgm./day, but by 20 days the rate had fallen to about 1·5 mgm./day. In practically all cases the tablets have been observed to be encapsulated on removal. Though the initial absorption rate is probably proportional to the surface area of the tablet, it is clear that in the present experiments the observed drop in absorption rate was not due to a decrease in tablet area as postulated on theoretical grounds by Emmens[3] and Forbes[4] for their rat experiments, since, after 63 days absorption, for example, the surface area had decreased by only about 8 per cent.

The question now arises as to whether the decrease in absorption is due to encapsulation, ghost formation or, perhaps, both. If ghost formation retards absorption, it would follow that tablets which had been implanted and removed from an animal would, if re-implanted into the same or another host, lose less weight in a given time than new tablets. The results given in the accompanying table, which are typical of others, bear out this expectation, thus showing that ghost formation is an important cause of absorption inhibition.

COMPARISON OF ABSORPTION RATES FROM NEW AND USED TABLETS OF PURE HEXŒSTROL.

No. of Tablet	No. and duration of previous implantations	Initial weight (mgm.)	Approx. surface area (mm.^{2})	Absorption (i.e., loss in weight) in 10 days (mgm.)
C12, cRM	—	1031	584	96·0
C12, cLM	—	1012	590	77·0
C12, cRF	1, (22 days)	862	540	6·5
C12, cLH	1, (22 days)	859	562	7·5
C12, cRH	2, (63 days, and 22 days)	822	539	5·0
C12, cLF	2, (63 days, and 22 days)	808	540	10·5

The tablets were subcutaneously implanted into separate sites in the neck region of a heifer for 10 days.

Moreover, from these and other at present unreported results, it appears that the retardation due to ghost formation is of sufficient magnitude to account for the experimentally observed decrease in absorption rate. This, though it suggests that encapsulation, at least under the conditions of these experiments, has little if any effect on tablet absorption, does not provide absolute proof of this. For it is possible to conceive of a retarding effect due to encapsulation being masked by a bigger effect due to ghost formation. This possibility could be tested if it were possible to prevent ghost formation by some method which had no effect on encapsulation. It may be recalled, however, that Emmens[3] observed encapsulation of tablets implanted into rats, but this did not appear to affect the absorption rate.

It is not yet known whether ghost formation occurs in tablets implanted into small animals but, as pointed out previously[1], it seems likely that the slowing up of absorption due to ghost formation may have to be taken into account in human therapy. These results will be reported in greater detail elsewhere.

Some of the hexœstrol tablets used in this work were provided by Messrs. Boots Pure Drug Co., Ltd., through the kindness of Dr. W. F. Short.

S. J. FOLLEY.

National Institute for Research in Dairying,
University of Reading.
Nov. 24.

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[1] Folley, S. J., NATURE, 150, 403 (1942).

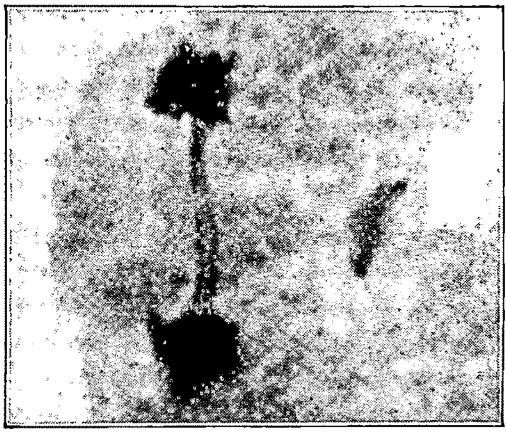
[2] Geist, S. H., Walter, R. I., and Salmon, U. J., *Proc. Soc. Exp. Biol.*, 43, 712 (1940).

[3] Emmens, C. W., *Endocrin.*, 28, 633 (1941).

[4] Forbes, T. R., *Endocrin.*, 29, 70 (1941).

The Telophase Split in Todea

I WAS interested in Dr. Manton's communication with her new and apparently incontrovertible evidence of the telophase split[1]. Her photograph *b* of somatic chromosomes in Todea shows clearly a displaced double strand which has been under a state of tension.



PHOTOGRAPH FROM A PERMANENT ACETO-LACMOID SQUASH[3] OF *Tragopogon pratense* ROOT-TIP SHOWING DOUBLE BRIDGE BETWEEN THE TWO ANAPHASE GROUPS FORMED BY THE DIVISION OF A DICENTRIC CHROMOSOME AND TO ONE SIDE A DOUBLE ACENTRIC CHROMOSOME (× 2000).

The displacement, as Manton points out, is no doubt due in part to squashing, but the stretched double strand is what one always sees with the double chromosome bridges so commonly found in somatic mitosis. For example, in root tips of three-day-old seedlings from two-year-old seeds of *Tragopogon pratense* I have noticed this type of bridge in twenty-two out of seventy-three anaphases. In all cases it was due to the formation of dicentric and acentric chromosomes by interchange in the preceding resting stage. These dicentric chromosomes divide in the three ways described by X-ray experimenters, for example, Koller[2].

The accompanying photograph is of such a dicentric chromosome bridge with its corresponding acentrics from *Tragopogon pratense* for comparison with Manton's photographs. The comparison shows that the so-called telophase split in *Todea* must also be interpreted in this way.

The lower end of the double strand in her Fig. certainly presents the appearance of two centromere which would be expected from the division of a dicentric chromosome. Further, some of the inclusion in this figure are perhaps in reality the acentrics which accompany dicentric bridges and can be of all the expected sizes. The bridges in such anaphase are, of course, always stretched naturally before fixation and not afterwards.

P. T. THOMAS.

John Innes Horticultural Institution,
Merton, S.W.19.
Nov. 13.

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[1] Manton, I., NATURE, 150, 547 (1942).

[2] Koller, P. C., *Genetica*, 16, 447 (plates VIII*b* and IX*a*) (1934)

[3] Darlington, C. D., and LaCour, L. F., "The Handling of Chromosomes" (London, 1942).

DR. MANTON's photograph[1], in which she claims to show an "incontrovertible evidence" of the telophase chromosome split, illustrates what can only be a dicentric chromosome. While the long arms form a bridge of the criss-cross type[2], the short arms lie across each other (*b* in photograph). They are the "two distinct separate threads forced widely asunder", and their thickness is the same as that of the long arms (*c* in photograph). The apparent gap between the centromere and the short arm of one chromosome as it is seen in *c* is due to excessive pressure in squashing the preparation.

P. C. KOLLER.

Institute of Animal Genetics,
University of Edinburgh.
Nov. 18.

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[4] Manton, I., NATURE, 150, 548 (1942).

[5] Husted, L., *Genetics*, 21, 537 (1936).

IT is perhaps unnecessary for me to inquire into the reasons for the assumption that the evidence from dicentric bridges in Tragopogon is incompatible with the existence of a telophase split in Todea, for the suggestion that the chromosome figured by me was a dicentric is not borne out by anything in the specimen itself. The accompanying diagram, based on my previously published photograph *b*, shows the region referred to. The two distorted chromosomes are labelled *chr* 1 and *chr* 2, *chr* 1 being that under discussion. In it "two distinct and separate threads have been forced widely asunder", the separation starting at a point near the intersection with *chr* 2 which is not otherwise of interest) and continuing to the distal extremity of the chromosome. Near this end both threads experience a sudden bend and the only point of uncertainty is whether or not they also cross over each other at this point.

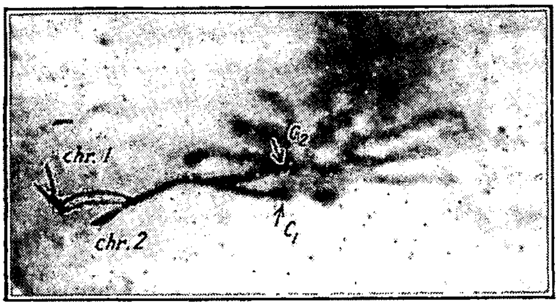

DIAGRAM DRAWN OVER A MATT-SURFACED PRINT OF THE PREVIOUSLY PUBLISHED PHOTOGRAPH *b*. FOR EXPLANATION OF LETTERING SEE TEXT.

The centromeres in both *chr* 1 and *chr* 2, as in all other chromosomes of this plant, are terminal or nearly so and their approximate positions are indicated by arrows and the letters *c* 1 and *c* 2. Owing to the predominance of terminal centromeres the question of short arms, in the form raised by Dr. Koller, does not arise. There are likewise no acentric fragments present, though some cytoplasmic inclusions may perhaps give the illusion of such in the reproduction and be the objects referred to by Dr. Thomas.

The suggestion made by Dr. Koller (if I have understood him aright) that the distal bend is a centromere is discountenanced by comparison with the sister nucleus. The significant part of this was shown in my previous photograph *a*. Had I anticipated that the number and position of centromeres would have been under discussion it would have been easy to show every chromosome in this nucleus by using two or three different focal levels. The level chosen was thought to be sufficient to indicate that the chromosomes were clearly distinguishable and were not disturbed in position. The full haploid complement of chromosomes was present in this nucleus, and therefore if *chr* 1 in the other plate was at any time a bridge it would be necessary to assume it to be a bridge which has broken and been displaced without leaving a trace of its former presence in the sister cell. This appears to me to be highly improbable and has not indeed been claimed.

My opinion that the cell in question was normal is naturally based on a wider knowledge of the material than the one specimen described. I am also acquainted with the appearances caused by dicentrics and fragments in some other organisms, but I have never encountered a case of the kind in the Osmundaceæ. Some positive evidence would therefore be required before one could assume the spontaneous production of chromosomal abnormalities of this kind in a healthy germination of fresh spores from a normal plant.

Further discussion may perhaps be left to the fuller statement which, as indicated in my former note, will be published elsewhere. Additional evidence, which is abundantly to hand, can then more easily be provided.

I. MANTON.

Botany Department,
University of Manchester.
Nov. 25.

Catalysts for Sodium Chlorate in Weed Destruction

BATES[1] has shown that vanadium pentoxide acts as a catalyst for sodium chlorate in weed destruction, and suggests the possibility of enhancing the value of this salt as a herbicide by the employment of a catalyst.

Compounds of manganese, cobalt and nickel act as catalysts in many oxidation processes. These metals frequently occur in plant tissues, and the first two are known to play an important part in their life processes, probably on account of their catalytic action. The effect of compounds of these metals on sodium chlorate, and on a proprietary weed-killer, 'Atlacide', which contains sodium chlorate and calcium chloride, has been investigated. The experiments included laboratory and small field tests. A few tests were also carried out with vanadium pentoxide.

The laboratory tests were made on the trailing stems of the Canadian blackberry, the wild dog-rose, and the wild bramble. The cut ends of the stems were placed in tubes each containing 50 c.c. of the solution under test. In most cases ten specimens were tested with each solution. The tests were as follows:

(1) Canadian blackberry stems in solution containing 10 per cent of sodium chlorate, and also with the addition of 0·03 per cent $MnCl_2.4H_2O$* ; 0·03 per cent $MnSO_4.4H_2O$* ; 0·02 per cent $KMnO_4$; 0·04 per cent $CoCl_2.6H_2O$* ; 0·04 per cent $NiSO_4.6H_2O$*.

(2) Canadian blackberry stems in solution containing 5 per cent of sodium chlorate, and also with the addition of 0·015 per cent $MnCl_2.4H_2O$; 0·015 per cent $MnSO_4.4H_2O$; 0·01 per cent $KMnO_4$; 0·02 per cent $CoCl_2.6H_2O$; 0·02 per cent $NiSO_4.6H_2O$; 0·03 per cent $MnCl_2.4H_2O$; 0·03 per cent $MnSO_4.4H_2O$; 0·02 per cent $KMnO_4$; 0·04 per cent $CoCl_2.6H_2O$; 0·04 per cent $NiSO_4.6H_2O$.

(3) Wild bramble stems in solution containing 2·5 per cent of sodium chlorate, and also with the addition of 0·015, 0·03, and 0·06 per cent $MnCl_2.4H_2O$.

(4) Wild bramble stems in solution containing 2·5 per cent of sodium chlorate, and also with the addition of 0·015 and 0·03 per cent $MnCl_2.4H_2O$; and 0·01 per cent V_2O_5.

(5) Wild bramble stems in solution containing 2·5 per cent of sodium chlorate, and also with the addition of 0·06 per cent $MnCl_2.4H_2O$; 0·08 per cent $NiCl_2.6H_2O$; 0·08 per cent $CoSO_4.6H_2O$.

(6) Wild dog-rose stems in solution containing 2·5 per cent of sodium chlorate, and also with the addition of 0·015 and 0·03 per cent $MnCl_2.4H_2O$; and 0·01 per cent V_2O_5.

(7) Wild bramble stems in 1 part 'Atlacide' concentrate to 3 parts water, and also with the addition of 0·03 per cent $MnCl_2.4H_2O$; and 0·04 per cent $CoCl_2.6H_2O$. The diluted concentrate contained 4·825 per cent $NaClO_3$.

(8) Wild bramble stems in a solution containing 0·06 per cent $MnCl_2.4H_2O$; 0·04 per cent $KMnO_4$; 0·08 per cent $CoSO_4.6H_2O$; 0·08 per cent $CoCl_2.6H_2O$; 0·08 per cent $NiSO_4.6H_2O$; 0·08 per cent $NiCl_4.6H_2O$.

* Approximately equal to 0·02 per cent of the anhydrous salt.

A 10 per cent solution of sodium chlorate is stronger than that usually used on this railway, therefore weaker solutions were also employed. The 2·5 per cent solutions were chosen because it was thought that such dilute solutions would not kill the specimens, or would do so very slowly, and that the effect of the catalysts would be more marked. The action was actually somewhat delayed, but all the specimens were killed in 10–18 days, and the action of the catalysts was not appreciably more marked than with the stronger solutions.

Similar results were obtained with all the catalysts. In each case the lethal effect of the chlorate was increased, as shown by the rate at which the specimens died, and the changes which took place in the leaves and stems. The vanadium pentoxide appeared to be somewhat more potent, and to make a more marked difference to the appearance of the plant; the leaves were more blackened and the stems more stained. Little, if any, difference could be observed between the effects of the other catalysts used. Although some effect was observable with 0·01 per cent of catalyst (calculated as anhydrous salt), there was more with 0·02, and still more with 0·04 per cent.

Different strains of the same species showed a marked difference in their powers of resistance. Thus, in test (2), a few stems were still but little affected when all the others were dead. The resistant specimens were all similar to each other in appearance, but differed considerably from the remaining stems. Similar results were obtained with the dog-rose and the wild bramble.

As was to be expected, the solutions of the catalysts alone had no appreciable effect upon the stems. Bates obtained the same result with vanadium pentoxide, and dilute solutions of the other compounds used are known to have a beneficial effect upon plants.

The field tests were carried out on plots each 4 sq. yd. in area, which were chosen so as to be as alike as possible, but considerable differences existed. In each case the weed-killer used was 'Atlacide'. The tests were as follows:

(1) Plots treated with
1 pint 'Atlacide' (1 part concentrate to 3 parts water); 1 pt. containing 0·015 per cent $MnSO_4.4H_2O$; 1 pt. containing 0·03 per cent $MnSO_4.4H_2O$.

(2) Plots treated with
1 pint 'Atlacide' (1 part concentrate to 5 parts water); 1 pt. containing 0·015 per cent $MnSO_4.4H_2O$; 1 pt. containing 0·03 per cent $MnSO_4.4H_2O$; 1 pt. containing 0·04 per cent $CoCl_2.6H_2O$; 1 pt. containing 0·01 per cent V_2O_5.

(3) Plots treated with
1 pint 'Atlacide' (1 part concentrate to 6 parts water; 1 pt. containing 0·03 per cent $MnCl_2.4H_2O$. Two plots were treated with each solution.

(4) Plots treated with
1 pint 'Atlacide' (1 part concentrate to 8 parts water); 1 pt. containing 0·06 per cent $MnCl_2.4H_2O$. Two plots were treated with each solution.

Although the differences between the different plots made close comparison difficult, by comparing the effects on particular species, for example, bindweed (*Convolvulus arvensis*), reliable comparisons could be made. It was evident, especially where weak solutions of 'Atlacide' were used, that the manganese salts were effective in promoting the lethal action of the herbicide. The effects of the other catalysts were not so definite, but this was probably because insufficient tests were carried out with these compounds.

The laboratory and small field tests both show that the salts of manganese, cobalt and nickel, as well as vanadium pentoxide, have an intensifying effect upon the action of sodium chlorate as a weed-killer. It is proposed to carry out larger tests on the track next season, in order to ascertain if the catalytic effect is sufficiently pronounced to justify the use of these materials in practice.

I desire to thank the Chief Engineer, Southern Railway, Mr. G. Ellson, for permission to publish this paper, and Messrs. the Atlas Preservative Company for supplying the sodium chlorate and 'Atlacide'.

ERNEST A. DANCASTER.

Chemical Laboratory,
Engineer's Department,
Southern Railway,
Wimbledon, S.W.19.

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[1] Bates, NATURE, **148**, 753 (1941).

Index of X-Ray Diffraction Data

IN response to the demand expressed at the Conference on X-Ray Analysis in Industry held at Cambridge last spring[1], the Institute of Physics has undertaken to supplement the index of X-ray powder patterns published by the American Society for Testing Materials[2]. The purpose of the index is to identify rapidly any substance that will give an X-ray powder photograph[3]. The work is being carried out in co-operation with the interested American bodies—the American Society for X-Ray and Electron Diffraction and the American Society for Testing Materials.

A considerable number of laboratories in Great Britain have furnished lists of substances for which they are able to supply data, and the 'editing' i being done at the Cavendish Laboratory. The purpose of this letter is to ask all people who have powder photographs of substances that might be suitable for inclusion in the supplement to communicate with Dr. A. J. C. Wilson, Cavendish Laboratory, Cambridge. A list of the substances already offered may be obtained from him on request

The X-ray index has already proved to be of considerable industrial importance, and an extensiv supplement will greatly increase its usefulness. It is hoped, therefore, that there will be a wide response to this appeal.

W. L. BRAGG
(President, Institute of Physics).

Cavendish Laboratory,
Cambridge.

NATURE, **149**, 503 (1942); *J. Sci. Instr.*, 19, 32, 80 (1942).

[2] NATURE, **149**, 437 (1942).

[3] *Indust. and Eng. Chem.* (Anal. Edit.), **10**, 457 (1938).

Errors in Mathematical Tables

I AM now trying to consolidate for publication partly in a new American National Research Counci quarterly, and partly in a book entitled "A Computer's Guide to Mathematical Tables", the work that I have done during the past twenty years of compiling lists of errors in mathematical tables. I should be glad to be told of any known errors i tables, or to have references to published lists. New of unpublished tables would also be appreciated.

L. J. COMRIE.

Scientific Computing Service, Ltd.,
23 Bedford Square,
London, W.C.1.

RESEARCH ITEMS

Starlings and Foot-and-Mouth Disease

There is a body of circumstantial evidence to support the view that the starling, *Sturnus vulgaris* (L.), is concerned with the spread of foot-and-mouth isease in cattle, and this has been reviewed by W. S. Bullough (*Proc. Roy. Soc.*, B, 131; 1942). It s desirable from this, as from more general points of view, that the life-history and habits of this bird hould be studied as fully as possible. The reproductive cycles of the British and Continental races of the starling have been investigated in considerable detail by Dr. Bullough (*Phil. Trans. Roy. Soc.*, B, 231; 1942). The British Isles have their own esident population of starlings, but during autumn and early winter this is augmented by invasions from he Continent. It is possibly significant that Scotland, here foot-and-mouth disease is rare, receives the bulk of its immigrants from Norway, where the disease is almost non-existent. England, on the ontrary, where the disease is common, receives its nflux from north Central Europe, where the disease prevalent, and many unexplained outbreaks start n the late autumn after the Continental migration f starlings has set in. The residents and migrants onstitute two different races which can be distinguished in both sexes by minor differences, but there also a difference in their reproductive cycles. The exual cycle of the British race commences earlier nd proceeds more rapidly, with the consequent arlier and quicker development of the breeding haracters. British starlings pair in autumn but the ontinental ones do not do so until they return to heir nesting places in March, and thus there is no nterbreeding between the two races (see also Nature, une 20, p. 683)

Great Barrier Reef Bores

Vol. 5 of the Reports of the Great Barrier Reef ommittee (dated April 30, 1942, and issued from risbane) has been drawn up by H. C. Richards and orothy Hill. They describe the detailed examination f two bores taken at Michaelmas Cay, 23 miles orth-north-east of Cairns in 1926 and at the southern nd of Heron Island in 1937. General accounts have ready been published. The sites were 700 miles part and the bores were put down to a depth of 0 ft. and 732 ft. respectively. The results of these oring operations are remarkably alike. The occur-ence of none but species of corals and molluscs which are found living in the same region to-day ndicates that the bores passed through materials eposited entirely during recent times. It is shown hat a subsidence of about 100 fathoms almost ertainly must have occurred, and this subsidence nd the deposition must have been rapid. The most mportant characters the bores have in common are he great thickness of reef materials in the upper part of each, the occurrence of reef corals through he top 506 ft. in the Heron Island bore and the top 76 ft. of the Michaelmas Cay bore, the occurrence of uartz-foraminiferal sands below the reef rock and he absence of a basement even at 732 ft. The bsence of dolomitization, the presence of two ragonite zones and the lack of sufficient cohesion n the material to yield cores comparable with those btained at Funafuti and the Bahamas show that milar conditions have affected the materials since heir deposition.

Vascular System of *Xenopus laevis*

While *Xenopus lævis* is the common form of Anuran amphibian studied in courses of biology in South Africa, only very inadequate and incomplete accounts of its blood vascular system were available until Naomi Millard's account appeared (*Trans. Roy. Soc. South Africa*, 28; 1941). This is a concise description of the arteries and veins of this species, fully illustrated by diagrams that are all the more clear since the vessels are shown in colour. Xenopus is an interesting species as it is a member of the Aglossa, whereas the previous accounts of the blood vessels of Anurans have been based on members of the Phaneroglossa. Investigations into other anatomical features of the group have suggested that it occupies a primitive position in the Anura. While the main plan of the vessels is undoubtedly Anuran, it is interesting to note that in certain details, particularly the veins of the hind limb and the abdominal veins, relationships are present that suggest conditions otherwise encountered in the Urodela, for example, *Salamandra salamandra*. The author concludes that these and other similarities do not imply close affinity but are rather due to both animals being neotenic. Some of the other peculiarities and abnormalities encountered will probably find explanations when the developmental history of the system is worked out. The abnormalities, a number of which are described, appear to occur in a greater percentage of the specimens than they do in the Ranidæ.

Effect of Colchicine

J. G. Hawkes (*J. Genetics*, 44, 11–22; 1942) has shown that colchicine only exerts its effect on those mitotic stages where a spindle mechanism is present. The centromeres of chromosomes treated with colchicine do not divide until the resting stage which follows the treatment, while the succeeding metaphase is followed by the formation of a lobed restitution nucleus. The orientation of the spindle in the root tip is distorted by colchicine, and this gives rise to the production of a swollen root tip. Absence of polarity of colchicine-treated cell divisions is a cause of the noticeable swellings of the roots. The duration of a cell-division cycle after colchicine is 33 hours in *Allium cepa*, which is about twice as long as a normal cell division in comparable circumstances.

Intergeneric Hybrids of Saccharum

Several hybrids between *S. officinarum* and *Narenga porphyrocoma*, made by C. A. Barber in 1913, have been analysed by E. K. Janaki-Ammal (*J. Genetics*, 44, 23–32; 1942). The parents have $2n = 80$ and $2n = 30$ chromosomes respectively. The hybrids have $2n = 55$ chromosomes. Chromosomes in the hybrid show autosyndesis and associate as quadrivalents, trivalents and bivalents. This may be the cause of male and female sterility in the hybrids, which would appear to be similar to the hybrid form 'Hitam Rokham' which is found wild.

Origin of Tetraploid Shoots in *Brassica oleracea*

H. W. Howard (*J. Genetics*, 44, 1–9; 1942) has analysed the origin of tetraploid shoots in *Brassica oleracea* after decapitation. New meristems arise from the cells of the callus, which were produced by large vacuolated cells. No increase in the proportion of the tetraploid shoots has been induced by treatment with hetero-auxin. The author considers it probable that tetraploid meristems arise from cells of the stem which contained diplo-chromosomes before injury, and that decapitation as such did not induce chromosome doubling.

Structure of Lead Chromate

The work of Brill (*Z. Krist.*, 77, 506 ; 1931) showed that lead chromate (crocoite) is monoclinic, that there are four $PbCrO_4$ molecules per unit cell, and that the probable space group is $C^{5}_{2h}-P2_1/n$. S. B. Brody (*J. Chem. Phys.*, 10, 650 ; 1942) has confirmed these data, which indicate that lead chromate cannot be classified with any other oxy-acid substance so far investigated. Simple rotation and Weissenberg equi-inclination X-ray photographs were taken about the *b* and *c* axes, using unfiltered copper radiation. The intensities were carefully corrected for polarization and absorption. Parameters for the lead and chromium atoms have been obtained but the electron density maps were insufficiently accurate to locate the oxygen parameters. There is evidence, however, that the structure is fairly close packed and that the co-ordination number of oxygen atoms about lead is probably 8 or more. It is concluded that the mechanism of photo-conductivity and photo-blackening in lead chromate must take place by migration of ions by means of holes due to lattice defects.

Counting Free Alkyl Radicals

An interesting method, whereby free alkyl radicals produced by photolysis can be counted, has just been published by M. H. Feldman, J. E. Ricci, and M. Burton (*J. Chem. Phys.*, 10, 618 ; 1942). Inside a reaction tube, long, heavy mirrors of lead are deposited and the lead is then carried from this tube by free alkyl radicals (Paneth method). The lead alkyl is brought in contact with a mixture of bromine and carbon tetrachloride whereby it is converted to lead bromide. Volatile substances are carefully distilled off and the lead determined by the dithizone method. Thus, assuming that all the alkyl radicals are 'mirror-active' and that only PbR_4 is formed, the number of radicals can be estimated. The half-life of the methyl radicals produced in the photolysis of acetone by 2537 A. mercury radiation at 45° is $1{\cdot}1 \times 10^{-2}$ sec. and at 100°, 8×10^{-3} sec. This difference appears to be due to the instability of free acetyl radicals produced according to $(CH_3)_2CO + h\nu \rightarrow CH_3 + CH_3CO$ and decomposing to CH_3 and CO. The concentration of free methyl radicals flowing past the irradiated portion of the tube has been computed to be approximately $1{\cdot}7 \times 10^{-12}$ mols per c.c. when $2{\cdot}7 \times 10^5$ c.c. of gas passes this point in 5 minutes. The number of mols of methyl picked up during that time at that point is $4{\cdot}6 \times 10^{-7}$.

Differential Electronic Stabilizer for Alternating Voltages

A paper read recently in London by Arvon Glynne before the Institution of Electrical Engineers describes the construction of a differential electronic stabilizer, which has been designed to provide a supply unaffected by fluctuations in the mains voltage, for testing A.C. instruments. A simple lamp stabilizer is also described. A bridge consisting of two lamps and two resistors is an essential part of the apparatus, for which the mathematical theory is developed, and experimental evidence of the accuracy of the theory is given. Applications of the differential stabilizer to the testing of D.C. and A.C. indicating instruments and of light- and heavy-current integra ing meters are described, and an account is given the use of stabilized voltages for A.C. potentiometr Both stabilizers have been in constant use for son time for standardizing instruments, and have prove to be very reliable and to require very little attentio When checking integrating meters, one observer now able to perform all duties, and it is believed th the precision of the measurements has been materiall increased. A single observer is now able to check a number of indicating instruments, as he is assure that the readings will not alter as he passes from o to the other. With the unsteady supplies previousl available, the A.C. potentiometer has been regarde as a troublesome and unreliable instrument unsui able for serious work, but it has now taken its prop place as a precision instrument. The stabilizer h been developed principally for use with single-pha supplies, but it can also be used with equal success f checking polyphase instruments.

Calculation of Precession

Star catalogues are now reduced to standa equinoxes at intervals of twenty-five years, an tables specially relating to the two epochs are com piled for the purpose, or more rigorous formulæ spherical trigonometry are used. In the case of sta of high declination, where a formal accuracy of least $0{\cdot}01^s$ in R.A. is desirable, it is often necessa to utilize the rigorous method. In these circum stances, where the spherical triangle involved small, Legendre's theorem can be applied, and t formulæ used produce errors which *decrease* as t pole is approached. This theorem states that cases where the sides of a spherical triangle are sma compared with the radius of the sphere, the spheric triangle may be replaced by a plane triangle, th sides of which are of the same length as the arcs the spherical triangle, but each angle is less by o third of the spherical excess than the correspondi angle of the spherical triangle. This principle h been applied in geodetic operations but has not be used in astronomical computations. D. H. Sadle superintendent of H.M. Nautical Almanac Office, h now shown (*Mon. Not. Roy. Astro. Soc.*, **102**, 4) ho the principle leads to some simple formulæ whi can be used for the reduction of star positions fro one equinox to another. They possess the gre advantage that accuracy of computation increas as the pole is approached, and they are easier to u than the ordinary rigorous formulæ employed spherical trigonometry.

Galactic Clusters in Relation to the Galaxy

As a result of his investigations, George Alt concludes that the observed distribution of clust numbers is due to a true eccentric displacement the sun in a real cluster system which is not mere a selection from a general random distribution (*Mo Not. Roy. Astro. Soc.*, **102**, 4). The centre of th cluster system is about 250° longitude. The asy metrical distribution of absorption conditions longitude as well as the presence of the so-call 'galactic windows' indicate that most of the absor tion is due to irregular clouds which accumula towards the galactic centre in the direction of 35 galactic longitude. In this direction the absorpti coefficient increases by about 5 per cent per ki parsec, but in any other direction the change smaller.

QUALIFICATIONS OF THE SOCIAL PSYCHOLOGIST

PROF. T. H. PEAR criticizes severely but kindly in an interesting article those who profess social psychology*. The social psychologist too frequently fails to qualify for his job by obeying the old injunction of 'know thyself'. Also in his attitude towards his subject he is too remote from the hurly-burly of everyday life, in fact, too 'pure'. Some sciences can be pursued advantageously with little contact with, or relation to, humanity, but such is not the case with social psychology. On the other hand, he must resist the temptation to slip into the attitude of the novelist, artist or even comfort lover.

The direction of any science is determined, to an extent not usually admitted, by the inborn and acquired mental peculiarities of its leaders and by their social and economic status. Most social psychology has been produced in Great Britain by members of the middle class, and they have too often been unaware of this limiting factor. Examples of this attitude of mind have sometimes been thrown into relief during the War. For example, in discussing fuel saving, some people who had never known what it was not to be able to have a bath when they wanted one, suggested a nation-wide campaign urging people not to have more than two hot baths a week, in blind ignorance that there were numerous bathless houses.

Leaders of thought brought up in a particular environment are apt to think that certain subjects are important or trivial, popular or dull, in general, though a different culture group might hold quite different views. A social psychologist must not be 'tuned in' merely to those expressions of social life which the conventions of his social milieu regard as important. For example, the subjects of speaking and conversing are generally neglected. That such problems as standard English, the prejudices for and against certain kinds of dialect, are social, is unrealized. To delve into them would break a taboo all the stronger because in most people it is unconscious.

Therefore, before entering upon any research in social psychology the investigator should know his own social background, and the ways in which it may have given him special prejudices.

Industrial research is not a bad training in this respect. If the investigator is in one factory for a considerable time, he will have ample opportunities for finding out, incidentally to his main work, what people do think, or say they think, about the topics that are of current interest. A point of importance in this connexion is that much of what is said has to be translated or interpreted. Some students of public opinion are apt to overlook that, in Great Britain at least, to express an opinion is not synonymous with being prepared to act upon it. Much gossip and expression of opinion is of the nature of a probe to see what other people are like or think.

The somewhat humdrum task of finding out how we ourselves behave in particular circumstances, and how others do, is vitally necessary for the development of social psychology.

Prof. Pear thinks that too many men of science believe that those who are not trying to establish general laws are wasting time, even when there may be a serious shortage of facts in the particular subject. Even books about the human mind are often of this kind and suffer from a paucity of examples. Social psychologists have no right to neglect the observation, recording and classification of concrete data. Their scientific training would be shown in the way they used their data. In short, they must not spend their days in the study, but frequent the market-place, and know their own blind spots, mental and social.

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* The Social Status of the Psychologist and its Effect upon his Work. By Prof. T. H. Pear, *Sociol. Rev.*, 34 (Jan-April, 1942).

SCATTERING OF LIGHT

THE interest which for many years now has been displayed by Indian workers on phenomena of light scattering has produced a large volume of valuable observations and many important and far-reaching results. While, since 1928, investigations have been predominantly concerned with different aspects of the Raman effect, other branches of light scattering have received attention. Many individual papers have appeared, but periodically a symposium of papers is published. These are most helpful in weaving together the various topics. The one under review* on "Fluorescence, Light Scattering, and the Raman Effect" worthily follows the traditions created by previous symposia and maintains the same high standard.

The symposium opens with two papers by P. G. N. Nayar on the absorption and scattering of light in diamonds. His earlier work had shown that both in fluorescence and absorption the entire spectrum is closely related to the 4152 A. band. Examination of these spectra at liquid-air temperature has now revealed the existence of a considerable number of discrete lines in the spectra with frequency shifts varying from 178 to 1330 cm.$^{-1}$ and, further, has shown the perfect mirror-image symmetry in the shifts and in the intensities of these lines with respect to the 4152 A. line. These data enable the author to derive the full lattice spectrum of the diamond, and the discrete character of this spectrum postulates that atomic oscillations in a simple crystalline solid are of a different nature from those of an elastic solid. Further, the derived spectrum contains practically all the known Raman and infra-red frequencies and indicates that the spectrum is richer in frequencies than had been supposed. The investigation of the ultra-violet absorption in the temperature range 85°–300° has demonstrated that the 4152 A. line is a doublet, that between 3015 and 3447 A. there are some twenty-five distinct lines, that below 3000 A. there is an unresolved group, and that the influence of temperature on all lines is of the same order of magnitude. Investigation of the changes in frequency, intensity, and polarization of the 1332 cm.$^{-1}$ Raman line with crystal setting and angle of scattering show that the frequency and intensity are unaltered. The depolarization factor is 1, not 2 as obtained theoretically. One other interesting point emerges in the constancy of the intensity and frequency of the 1332 cm.$^{-1}$ line in diamonds exhibiting widely different fluorescence and absorption properties.

B. S. Satyanarayana discusses the fluorescence of uranyl compounds. In the solid state the fluorescence spectrum consists of eight discrete bands having a wave number separation of approximately 860 cm.$^{-1}$. The Raman spectrum of the uranyl $UO_2{}^{++}$ ion con-

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Proc. Indian Acad. Sci., *A*, 15, 293-416 (1942).

sists of three displacements of 211, 865, and 909 cm.$^{-1}$. It is concluded from an analysis of the Raman data that the ion has a symmetrical, bent structure.

More than workers in other countries, Indian physicists have directed attention to the interesting changes in the Raman spectra of crystals on account of different crystal settings, and of the influences of the directions of the incident and scattered radiation. T. M. K. Nedungadi has extended our knowledge on this topic by an exhaustive investigation of the Raman effect in a single crystal of naphthalene. The spectrograms obtained for various settings of the crystal with respect to the directions of the incident radiation and the line of observation and with various directions of vibration in the incident and scattered radiation are reproduced. Experimental data confirm predictions of group theory that six low-frequency lattice oscillations exist in three pairs of close doublets: 38, 47; 72, 78; and 107, 121 cm.$^{-1}$. The higher member of each pair arises from oscillations symmetrical to the elements of symmetry of the monoclinic lattice, whereas the lower members of the pairs are due to antisymmetrical oscillations. On frequency and intensity considerations these pairs of lines correspond roughly with rotational oscillations of the molecule. Theoretically, naphthalene should possess twenty-four normal modes of vibration and these have been identified. Polarization data have shown that some of the internal oscillations, particularly 512 and 1576 cm.$^{-1}$, split up into symmetric and antisymmetric components; this is interpreted as showing that polarization data are controlled, as are lattice oscillations, by symmetry properties.

Work continues on determination of the Raman frequencies and their intensities and polarization characteristics and on deducing the characteristic Raman frequencies of chemical groups and linkages. Contributions in this direction are made by Dr. C. S. Venkateswaran and N. S. Pandya with data on aniline, diethyl sulphide, and two binary liquid mixtures. The binary mixtures investigated—*cyclo*hexane-aniline and *iso*-propyl alcohol-water—possess a critical solution temperature and, from changes in the position and intensity of five lines of the second mixture, it is concluded that at the critical solution temperature only monomeric molecules of *iso*-propyl alcohol exist. This is an interesting new departure in Raman spectral investigations, and shows that the directions in which the methods of Raman spectra can be applied to the investigation of chemical problems are, indeed, manifold.

The remaining papers of the symposium deal with the scattering of light in gases, in mobile and viscous liquids, in glasses, in alcohols, and in emulsions. The light scattered in a transverse horizontal direction by dilute emulsions is usually elliptically polarized, whereas the scattered light from concentrated emulsions is highly depolarized. In a large variety of liquids hypersonic velocities have been determined and compared with acoustic velocities. K. S. Bai has examined existing theories of light transversely scattered by liquids and has derived thermodynamically a general expression for the intensity.

The contents of the papers constituting the symposium will prove extremely valuable not only to all directly concerned with this field of scientific inquiry, but also to a wide circle of chemists and physicists interested in the applications of these methods to a variety of problems.

W. Rogie Angus.

THE LOCUST PLAGUE

By Dr. A. D. Imms, F.R.S.

One of the oldest of all agricultural problems is that of locust invasions. References to such plagues are frequent in the texts of the ancient Egyptians, Greeks, Chinese and Hebrews—the oldest dates back to more than 2000 years B.C. These depredations are not confined to a few countries, although outbreaks regularly appear in individual lands only to devastate many distant territories. It cannot be emphasized too strongly that much of the failure to control these plagues has been due to isolationist policy adopted by those countries directly affected.

This feature was stressed by Dr. B. P. Uvarov in a lecture delivered by him before the Dominions and Colonies Section of the Royal Society of Arts on December 15. As Dr. Uvarov pointed out, history provides examples of great efforts to control locusts in Algeria, Argentina, South Africa, etc., with only temporary results simply because the problem is insoluble within the confines of a single country. He mentions the example of swarms of the desert locust, bred in India, that usually migrate to Persia and Arabia and their descendants proceed to spread over Egypt, Palestine and East Africa.

It is now generally agreed among investigators, and the more enlightened administrators of locust control methods, that international co-operation affords the only sure method leading to the ultimate and permanent solution of the problem. Sporadic attempts to approach some measure of international co-operation have not been lacking, but no practical effect resulted owing to failure to take scientifically planned concerted measures. In 1928 a severe outbreak of the desert locust was the moving factor in the British Government deciding to take steps that might lead to a solution of the causes of the periodical swarming of locusts and the resulting depredations. A Locust Sub-Committee of the Committee of Civil Research (later transformed into the Committee on Locust Control of the Economic Advisory Council) was formed. The actual work was undertaken by a special research unit under the supervision of Sir Guy Marshall and under the technical supervision of Dr. B. P. Uvarov. The history of this important venture and the results so far obtained were dealt with in the lecture referred to. In a few words it may be said that this purely British organization soon attracted attention in other lands.

The first International Locust Conference at Rome in 1930 requested the British organization to act as the centre of anti-locust research. Concerted investigations by parties of British, Belgian, South African, Egyptian and Indian experts have gradually led towards a fundamental understanding of the whole problem. After eight years of intensive work it has become possible to formulate a policy that aims directly at a radical solution of the difficulties. The investigations referred to have yielded abundant data showing that the periodicity of locust outbreaks is closely connected with transformation of these insects from the harmless solitary phase into the dangerous migratory, gregarious one. The transformation can happen only in certain localized areas with special conditions of climate and vegetation which differ for different locust species. It is in these outbreak areas that the first swarms are formed. The important discovery that great locust invasions have such restricted beginnings has vital implications. It means that once these original outbreak areas are known they can be kept under proper observation, and any tendency towards the formation of incipient swarms can be dealt with before such swarms can spread and cause widespread devastation. It cannot be too strongly emphasized that Dr. Uvarov himself is the guiding agent in all this international locust policy, as it was his original phase theory that provided the scientific basis for the new outlook on the problem as a whole.

STUMP PRODUCTION IN MADRAS TEAK NURSERIES

WHAT has come to be known as stump planting, that is, the use of root and shoot cuttings, has been long known in India, some of the earliest experiments made in this direction having been successfully attempted with the sissu (*Dalburgia Sissoo*) in the irrigated plantations in the Punjab. In *Indian Forest Records*, 4, No. 5, 1941 (Manager, Government of India Press, New Delhi, 1942), A. L. Griffith says that the planting of stumps in Madras displaced direct dibbling of seed and transplanting, as had been done up to that time. In the early days of stump planting in the presidency a number of experimental investigations were undertaken and continued over some years. Mr. Griffiths summarizes the results in the following tentative conclusions for work in a general West coasts type of climate:

(*a*) The best density of sowing to use is that of 1/8 lb. to 1/5 lb. of teak seed per square foot of nursery bed, and to do no pricking out of seedlings at all. This is most economical in quantity of seed and results in a high proportion of the stumps produced being of the best size for planting at 1 year old (that is, 0·4–0·8 in. diameter). (*b*) Thus, one standard 40 ft. × 4 ft. nursery bed sown evenly with 20–30 lb. of seed *on the average* produces enough well-shaped stumps of usable size to plant 1 acre of plantation at a 6 ft. × 6 ft. espacement and also leaves in reserve for casualty replacement. (*c*) Poor seed years have to be guarded against, and at the end of the first year either the undersized plants can be left in the bed and these together with germination from seed still dormant will produce a full bed of good-sized plants at the end of the second year, or the undersized plants can be pulled out with the bigger ones, stumped, and put back into a reformed nursery bed. These plants at the end of the second year will give a high proportion of well-shaped, good-sized stumps which are in no way inferior to fresh, good-sized one year old stumps. (*d*) Although teak stumps store well, and travel well, a large central permanent nursery for the production of stumps for an extensive area does not appear advisable, as in a few years stump production falls off seriously in most localities as a result of continued cropping, and this falling off was not prevented by manuring with artificial manure, or by fallowing, or by growing a green manure crop of sunn hemp in alternate years. In addition, pest attack by cockchafer and white ants may be serious in a permanent nursery and occurred in two out of the five years of experiment.

The conclusion arrived at between the permanent and the temporary or flying nursery is most important and of high interest,

ANALYSIS OF ELECTRICAL CONTACT EFFECTS

IN a paper entitled "Contact Non-Linearity, with reference to the Metal Rectifier and the Carborundum Ceramic Non-Linear Resistor" (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 23; November 1942), A. Fairweather gives an account of an experimental analysis designed to correlate and formulate the behaviour of various structures possessing contact non-linearity. New data are presented concerning representative contact combinations such as various carborundum combinations, the carborundum ceramic non-linear resistor, the cuprous oxide and selenium rectifiers, and the diamond. Measurements have been made of the variation of the characteristic parameters, resistance and capacitance, with each of the four significant variables—current, mechanical pressure, thickness of semi-conductor and temperature. The ranges of current and voltage far exceed those which have been employed hitherto. Examination of the results obtained leads to various conclusions regarding the mechanism of contact non-linearity, but not, however, in conflict with the familiar 'barrier layer' hypothesis, which is fully supported by the work described.

It would seem that three clearly defined regions of operation hold for conduction in both directions through a contact possessing contact non-linearity. For 'small' voltages and for 'large' voltages conduction is ohmic: for 'medium' voltages, which are largely those of interest, conduction is non-linear, and obeys a simple empirical equation of the form $V = Ki^n$, where n depends mainly on the materials, and K on the dimensions, of the contact combination. This type of law might hold for all contact combinations, and its importance is such as to warrant the development of a theory of circuits containing a non-linear resistor having such a characteristic. Since the contact is never likely to be perfect, the current will be concentrated at a number of spots which may be regarded as imperfections in the boundary. The 'small' voltage ohmic resistance is thus identified as a constant resistance arising from spreading current paths associated with these spots. The 'large' voltage ohmic resistance is due to the resistance of the bulk electrodes, which becomes all-important when the boundary resistance has become sufficiently small. The 'medium' voltage non-linear resistance results from conduction across the nominally insulating portion of the boundary.

The simple gap picture of the boundary seems to have been discarded prematurely. In the case of the cuprous oxide rectifier, where it is generally supposed that the boundary layer consists of highly insulating, oxygen-free cuprous oxide, such gaps might result from intercrystalline or crystalline cracking at the boundary, arising during cooling from the high temperature of preparation, and this picture is in closer agreement with the results of experiment. The importance of two much neglected aspects of contact non-linearity are stressed: first, the capacitance parameter, as a possible source of information regarding the insulating portions of the boundary layer, and secondly, the necessity for using structures which are previously unstressed mechanically, for detailed study.

Carborundum, cuprous oxide, and selenium are all shown to be ohmic conductors, in opposition to the views of some workers. The tests on contacts between diamonds—a very high-resistance crystalline material —have suggested the probable existence of an apparently anomalous effect, in that the contact resistance in the non-linear region increases with increasing voltage. This is thought to be related to the familiar resistance maximum occurring in the reverse direction with the metal rectifier.

FORTHCOMING EVENTS

Sunday, December 20

Workers' Educational Association (Glasgow Branch), Association of Scientific Workers (Scottish Area), Workers' Educational Trade Union Committee (Scottish Area), and the Educational Institute of Scotland (Glasgow Association) (in the Glasgow and West Scotland Commercial College, Pitt Street, Glasgow, C.2).—Joint Conference on "Science and the Struggle for Freedom". At 10.30 a.m.—Prof. H. Levy, Prof. V. Gordon Childe and Dr. C. Ockrent: "Science in the Struggle against Fascism"; at 2.30 p.m.—Dr. Martin Ruheman, Dr. F. Haldane and Mr. C. R. Wason: "Science in the Soviet Union".

Monday, December 21

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Mount Everest Films from the Expeditions of 1922 and 1933 and the Flight of 1933.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Teacher (man or woman) of Mathematics in the Technical Day School—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17 (December 23).

Assistant Mistress to teach Biology and some subsidiary Chemistry and Physics—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (December 28).

Assistant Lecturer and Demonstrator in Botany—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (December 28).

Woman Psychologist for service at the Child Guidance Clinic—The Chief Education Officer, Education Office, Council House, Margaret Street, Birmingham 3 (January 9).

Regius Professor of Geology at Edinburgh University—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (January 11).

Graduate fully qualified to teach Physics—The Headmaster, Royal Liberty School, Romford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 27: Rubber, Polyisoprenes and Allied Compounds. Part 2: The Molecule-Linking Capacity of Free Radicals and its Bearing on the Mechanism of Vulcanisation and Photo-Gelling Reactions. By E. H. Farmer and S. E. Michael. Pp. 8. Publication No. 28: The Interaction between Rubber and Liquids. 3: The Swelling of Vulcanised Rubber in Various Liquids. By G. Gee. Pp. 6. Publication No. 29: The Crystal Structure of β-Isoprene Sulphone. By E. G. Cox and G. A. Jeffrey. Pp. 8. (London: British Rubber Producers' Research Association.) [1111

War-Time Information for Pharmacists. Compiled by the *Pharmaceutical Journal*. Pp. 54. (London: Pharmaceutical Press.) 1*s*. [1211

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 4: The Identity of the Top-Necrosis Virus in up-to-date Potato. By Phyllis E. M. Clinch. Pp. 18–34+1 plate. 2*s*. Vol. 23 (N.S.), No. 5: Formation of Gynospore, Female Gametophyte, and Archegonia in *Sequoia*. By W. J. Looby and J. Doyle. Pp. 35–54. 2*s*. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.: London: Williams and Norgate, Ltd.) [1311

Ministry of Agriculture and Fisheries. Bulletin No. 101: Hedge and Tree-Stump Clearing. By Dr. T. Swarbrick. Fourth edition. Pp. ii+13+4 plates. (London: H.M. Stationery Office.) 6*d*. net. [1811

Royal Meteorological Society. Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Vol. 5, No. 3 (January–June 1942). Pp. 29–46. (London: Royal Meteorological Society.) 2*s*. 6*d*. [2511

Institute of Chemistry of Great Britain and Ireland. Lecture on Rust-, Acid- and Heat-Resisting Steels. By Dr. W. H. Hatfield. Pp. 48. (London: Institute of Chemistry.) [2511

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 3, No. 17: Axiomatic Treatment of Kinematical Relativity. By Dr. G. C. McVittie. Pp. 210–222. 1*s*. Vol. 61, Part 3, No. 18: Heat Flow in the Region bounded Internally by a Circular Cylinder. By J. C. Jaeger. Pp. 223–228. 6*d*. Vol. 61, Part 3, No. 19: A Short Table of I (0 1; x). By J. C. Jaeger and Martha Clarke. Pp. 229–230. 6*d*. (Edinburgh and London: Oliver and Boyd.) [2511

Freshwater Biological Association of the British Empire. Scientific Publication No. 7: Keys to the British Species of Ephemeroptera with Keys to the Genera of the Nymphs. By D. E. Kimmins. Pp. 64. (Ambleside: Freshwater Biological Association.) 2*s*. 6*d*. [2511

Social Insurance and Allied Services. Report by Sir William Beveridge. (Cmd. 6404.) Pp. 299. (London: H.M. Stationery Office.) 2*s*. net. [212

City and Guilds of London Institute. Report of the Council to the Members of the Institute for the Year 1941. Pp. xlv. (London: Gresham College.) [212

Haemoglobinometers, Haldane Type. (British Standard 1079: 1942). Pp. 12. (London: British Standards Institute.) 2*s*. net. [212

Other Countries

Smithsonian Miscellaneous Collections. Vol. 103, No. 3: A Revision of the Indo-Chinese Forms of the Avian Genus Prinia. By H. G. Deignan. (Publication 3689.) Pp. ii+12. (Washington, D.C.: Smithsonian Institution.) [1311

American Museum of Natural History. Vol. 80, Art. 4: The Osteology and Relationships of the Elephant Shrews (Macriscelididae). By Francis Gaynor Evans. Pp. 85–125. (New York: American Museum of Natural History.) [1611

Brooklyn Botanic Garden Record. Vol. 31, No. 4: Prospectu 1942–1943, including Victory Garden Courses. Pp. viii+211–249. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [1611

Trinidad and Tobago: Forests Department. Administration Report of the Conservator of Forests for the Year 1941. Pp. 4. (Trinidad and Tobago: Government Printer.) 4 cents. [161

Transactions of the San Diego Society of Natural History. Vol 9, No. 34: Foraminifera from the Type Area of the Kreyenhagen Shale of California. By J. A. Cushman and S. S. Siegfus. Pp. 385–426+plates 15–19. Vol. 9, No. 35: Two New Wrens and a New Jay from Lower California, Mexico. By Laurence M. Huey. Pp. 427–434. Vol 9, No. 36: A New Race of the Rusty Sparrow from North Central Sonora, Mexico. By A. J. van Rossem. Pp. 435–436. Vol. 9, No. 37: A New Flea of the Genus Ceratophyllus. By G. F. Augustson. Pp 437–438. Vol. 9, No. 38: A Pleistocene Tortoise from the McKittrick Asphalt. By Loye Miller. Pp. 439–442. (San Diego, Calif.: San Dieg Society of Natural History.) [181

Records of the Geological Survey of India. Vol. 77, Professional Paper No. 2: A Geological Investigation of Tunnel Alignments fo the Jumna Hydro-electric Scheme. By J. B. Auden. Pp. 29+10 plates (Calcutta: Geological Survey of India.) 2.8 rupees; 4*s*. [241

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ANGLO-AMERICAN COLLABORATION IN AFRICA

AN admirable study of Africa and the Atlantic Charter from what might well be called the point of view of the United Nations has been issued by the Committee on Africa, the War and Peace Aims*. Its main purpose is to help to focus public opinion on the constructive treatment of African problems, and in presenting a document suitable as a basis for study in various groups in the United States, the Committee has also provided one equally fitted to promote in Great Britain the long neglected cause of education in imperial history. Attention is indeed concentrated on European-African relations, and the differences in the policies of different European Governments are recognized, as well as those existing between areas of large white permanent settlement such as Southern Rhodesia, Angola and South-West Africa, and to a lesser extent Kenya, and those like Nigeria, the Gold Coast and West Africa, where there is no such group. The solution of African problems is a complicated one, and the presence of those qualified to deal with African problems will be essential at the peace conference if that settlement is to implement a constructive attack on the problems of African poverty and retarded development with the definite object of fitting the African for self-government.

From the major findings of this Committee there will be little dissent. The need for intelligent study of Africa, its position as a great undeveloped area with minerals, agricultural land, water-power and other natural resources steadily decreasing in value through careless or reckless use or exploitation, the differing policies of the various European powers in control, the potentialities of the indigenous peoples—with these Lord Hailey's larger survey has already done something to familiarize opinion. There is generous recognition in this report of the integrity and personal character of the British Colonial service, of the pursuit of progressive social welfare ideals, and of the progress made in most parts of Africa under the influence of the mandate idea of trusteeship in dealing with the problems of native rights and welfare. It should not require the stimulus of the American landings in Liberia and in Northern Africa to accord equally full recognition of America's missionary, financial, educational, scientific and other interests in Africa, all increased by the existence in the United States of the largest educated Negro population in the world.

The recommendations of the Committee are equally in harmony with the policy of development to which Great Britain has committed itself in the establishment of the Colonial Development Fund, and still more that new conception of wardship which Lord Hailey has emphasized as needed in place of the older conception of trusteeship, with its implication of status rather than development. They are in fact largely anticipated by the proposals of a P E P broadsheet issued earlier in the year.

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* The Atlantic Charter and Africa from an American Standpoint: a Study by the Committee on Africa, the War, and Peace Aims. Pp. xi+164. (New York: The African Bureau; London: Edinburgh House Press, 1942.) 75 cents; 4s.

The Africa Committee urges that the lessons of recent military defeats in Malaya, Java and Burma emphasize the importance of prompt steps to give Colonial peoples a larger and more responsible share in the government of their country; otherwise measures to meet their legitimate aspirations may be "too little and too late". The close analysis of each of the eight points of the Atlantic Charter leads to the recommendation that each point should be applied to Africa in keeping with the broad humanitarian and democratic principles enunciated. The goal of ultimate self-government should be accepted for all the Colonies, and every effort made to secure the best public opinion of the African population when changes in government control or policy are contemplated, to provide adequate local representation in the machinery of government either in the legislative council or by tribal councils, and to open positions in the Civil Service in every Colony of the country to Africans.

Like Lord Hailey, the Committee endorses the conception of guardianship rather than of trusteeship, with its implication of temporary rather than permanent relationship, but otherwise it strongly supports the application of the mandate ideal both in those territories controlled by European powers and in the independent African States. In regard to social and economic relations, it stresses the importance of the elimination of all forms of racial discrimination, of special attention to the fundamental problems of land and agricultural development, the prevention of exploitation and deterioration of natural resources, and an educational policy related to the needs of the people and calculated to provide the leadership required in all branches of life. The exceptionally serious health problems of Africa are also recognized as requiring special attention.

There can be no doubt as to the sympathy and understanding with which African problems are viewed by those responsible for this report, and American co-operation in so cordial and generous a spirit should be sure of a warm welcome. America's own mistakes in dealing with racial problems are frankly recognized, and this call, addressed primarily to the people of the United States for a keener interest in African affairs and for closer relations with Africa, will be strengthened by the stimulus which the march of events has given.

Whether or not the Government of the United States is likely to consider the final recommendation of this Committee regarding the establishment of a separate Division, staffed mainly with personnel with African experience, to deal with African-American affairs, in place of the old system in which such matters were handled by the Near East Division or the West European Division, a Colonial commission working through such institutions as the regional development agencies and international public concerns suggested in the Planning broadsheet and discussed recently by Dr. Julian Huxley in the *Political Quarterly* seem to offer an effective channel for American co-operation. There is no gap between progressive thought in Great Britain and that in the United States on Colonial affairs—indeed, if anything the more immediately practical and constructive proposals have come from groups in Great Britain, as might be expected from the somewhat closer contact with African affairs. What is important is that there should be goodwill and understanding on both sides, and the determination to work together in support of the great ideals which the two Anglo-Saxon democracies share.

This report will encourage that understanding in the United States, and also the sympathetic approach to African problems which takes account not merely of the ideally desirable but also of the practicable. The Committee, it will be noted, does not go so far as to prescribe a time-table as does Mr. Wilkie, and the need for flexibility is recognized. Such moderation is all the more calculated to influence opinion in favour of that closer concern with problems of welfare, of nutrition and social and economic development, in place of the political problems with which British Colonial administration has been sometimes excessively concerned in the past.

Walter Bagehot once reminded us that the British Empire is in danger of falling through not understanding the greatness of the institutions which it has created. Co-operation between the United Nations cannot be based on the liquidation of the British Empire, but on its continuing evolution as a system of free co-operation. The achievements as well as the mistakes of the past must be recognized. The disasters in Malaya, Burma and Java must not lead us or our allies to forget that the links which hold together the British Commonwealth of Nations bore alone for more than twelve months the strain of the fiercest assaults upon the bastion of freedom in Great Britain. Mr. Churchill's words should rather stir us to remember the responsibilities of Empire and to make the Empire a shining example of the free and full development that can be achieved by democratic means.

Fortunately it is clear from Lord Cranborne's statement on behalf of the Government and other declarations that there is already a large measure of agreement among progressive opinion on the Colonial question in Great Britain and the United States. The general trend presupposes a minimum of internationa organization, sufficient to guarantee security from aggression and to promote economic stability. The pooling of Colonies under an international body is rejected in favour of the adherence of all Colonia powers to a Colonial charter, the raising of administrative and labour standards by a series of international conventions and the general supervision o Colonial administration by an international Colonia Commission. Furthermore, the development of the tropical Colonies is regarded as one of the major economic priorities before the world, and where the general consensus of opinion would part company from Mr. Wilkie is in regarding this question of development not as one for a rigid time-table but rather of how to raise the standard of existence in these backward areas with optimum rather than the maximum speed.

This all pre-supposes a common outlook on Colonia questions and the wholehearted adoption not by any one Colonial power but by all the United Nations of this principle of guardianship, with its implication of full partnership in due course. With that presupposition would go an understanding which should facilitate co-operation in even wider fields. Moreover, whatever the precise form which the Colonial Commission may take under international organization, it must provide the necessary flexibility, so that organizations can be developed which are appropriate to the particular service required and the conditions of the community to be served. There must be vision and imagination, and the willingness to build on the best available experience from whatever source, rather than the attempt to copy slavishly the Tennessee Valley Authority, or any other particular type.

To fulfil its essential functions, whatever authority is established for co-operative attack on this great problem of Colonial development, the planning, advisory functions and financial assistance will require the help of an international research staff. Many of the problems are clearly far beyond the scope of the Colonial Development Fund already initiated by Great Britain. The survey of resources involved, with research into anthropology, water-power, mineral and forest reserves, soil erosion, agriculture, transport, marketing problems, health, trends of population and the prospects of export and import trade call for a common policy as well as for the resources of more than one Colonial power. The very effort involved should promote an understanding which would go far to eliminate some of the sources of friction which Colonies have provided in the past.

Appreciation of the fine work done by British administrators in the past suggests at once how fitting it is that Anglo-American co-operation should lead the way in the evolution of a new Colonial system. To treat the Colonial peoples as human beings, who are to be guided, helped and developed towards political and cultural equality, is in keeping with the finest traditions of both peoples. That new outlook was reflected in Mr. Eden's speech at Edinburgh last July, as well as in those of Mr. Wilkie, Mr. Appleby, and other American leaders. It was emphasized once more in General Smuts's historic speech. The United Nations cannot form the core of a better organized world and exclude Colonial policy from their common interest. The large principles of social policy, the principle of international help underlying the mutual aid agreements, like the large principles of international social and economic policy embodied in the Atlantic Charter, must apply to all humanity. The United Nations are already committed to improved standards of living for the peoples of the world and to the promotion of an expanding and non-discriminating trade. As we take up that task in association with the United States, and seek to forward the health and welfare of all peoples, Colonial or not, there will be cultivated a new spirit of human solidarity, and economic conditions can be established which strike at the root causes of war and lay deeper foundations for world peace. The whole tradition and history of Great Britain and the United States make it fitting that together they should lead the way, and their ability to formulate a common policy and reach full understanding on Colonial questions is a touchstone of their capacity for world leadership in the wider areas covered by the Atlantic Charter. But that partnership must be based on full knowledge of each other's achievements, and appreciation of what is good and valuable in those achievements; and the first condition of success is that the task of understanding should be attempted now with honesty and sincerity.

BEARING OF MODERN RESEARCHES ON EVOLUTION

Evolution

The Modern Synthesis. By Dr. Julian Huxley. Pp. 645. (London: George Allen and Unwin, Ltd., 1942.) 25s. net.

IN the four decades from the publication of the "Origin of Species" in 1859 to the end of the nineteenth century, evolution held the centre of the stage in biology. With the rediscovery and confirmation of the facts and theories of Mendelian inheritance in 1900, there followed a period of intensive study of variations and their modes of transmission. To a considerable extent the early work on mutations prepared the way for the rapid development of experimental methods in the study of heredity. In due course Mendelian theory became closely associated with modified concepts of mutations and with certain aspects of chromosome structure and behaviour. It remains an interesting historical fact that during the first three decades of the twentieth century evolutionary concepts developed very little; indeed, in some biological circles evolution was almost a taboo subject. The position may be accurately gauged by the general tone of Bateson's presidential address at the British Association's meeting in Australia in 1914, approximately in the middle of this period, and even by the following single sentence from this address: "It is no time to discuss the origin of the Mollusca or of Dicotyledons, while we are not even sure how it came to pass that *Primula obconica* has in twenty-five years produced its abundant new forms almost under our eyes". A further change in biological thought has become evident during the past ten years. To a certain extent, there has been a move back in interest and emphasis from heredity to evolution, but advance is marked by the acceptance of new theories, while the old theories are in part strengthened and in part discarded.

The above generalizations have many exceptions and the terms of years suggested do not fix exact limits to complete saltations of subject, method or theory. There is, however, no doubt that many biologists feel that the time has arrived when the discoveries of the past thirty or forty years, in cytogenetics and ecology in particular, should be applied to the more extensive problems of evolution and, it may be added, of systematics. No one has more clearly visualized the need for such a synthesis and the wide field of possibilities it opens up than Julian Huxley. His wide and sympathetic approach to evolutionary problems was clearly shown in his introductory chapter and general editorship of "The New Systematics" (Oxford, 1940) and is set forth in much greater detail in this new book. These two volumes probably mark the first stages in the renewed fight against isolationism in biology. Special researches must continue, but it is becoming more and more clearly recognized that their results often have a deeper and wider significance than the specialist himself realizes. Biologists are fortunate in having had made available in book form not a culling from thirty-five pages of references but a concise synthesis of an extensive range of modern knowledge upon evolution. It is of particular importance that this work should be published now. A very large number of biologists have had their work interrupted or deflected by special service in or for the war effort. It may be hoped and expected that in the years of peace to come "Evolution: the Modern Synthesis" will serve as a restarting point for many of us, and will also act for a very long time as a stimulus to those who will become biologists under what may be quite new conditions.

It is impossible to review at any reasonable length the detailed contents of this volume. It is, however, not difficult to indicate its main features and conclusions. Three conclusions stand out strikingly: that natural selection of variations, with some modifications of Darwin's point of view, is the most important known means by which evolution is directed; that variations themselves originate in many ways and are correspondingly diverse; and that neither mutational variation nor selection alone is creative of anything important in evolution, though the two in conjunction are creative. Both variation and selection are shown to be far more complex than could possibly have been realized but for very recent researches. The multiformity of evolutionary processes is almost as great as the heterogeneity of the results. The essential synthesis is between the kinds and methods of variation and the kinds and methods of selection leading to the diversification of organisms. This diversification is expressed in taxonomic schemes of a hierarchical nature, and, for a variety of reasons, interest has particularly centred around speciation.

Acceptance of the mutation theory, in its modern form, explains, up to a point, how variations arise. Mutations have been shown to involve many kinds of structure and many kinds of function. Moreover, they are of all grades of importance in that differences arising particulately may be very considerable or very minute. Genes, and consequently mutated genes, combine to form different gene-complexes, and the gene-complex as a whole may influence the action and expression of any gene in the complex. Further light is thrown on variation, and on its converse, conservatism or stability, by many recent cytological and cytogenetical studies which have led to the discovery of inversions, translocations, reduplications, etc., within chromosomes, resulting in marked position effects, and to the widespread occurrence of polyploidy, especially in the plant kingdom.

The author devotes three chapters to the problems of speciation. These chapters contain a great range of facts and set forth very clearly many of the difficulties which taxonomists have to face. In actual practice the hierarchical system, of families, genera, species, etc., has been found to work better than any other for a wide range of purposes. It is, however, clear that there are a number of quite different *kinds* of animal and plant species—and the same is true for other taxonomic grades. Speciation may be essentially geographical, ecological, or cytogenetical. The clear and concise attempt (pp. 407–8) to tabulate "the main kinds of taxonomic units with concrete existence as natural groups" is very interesting in that it allows a wider range of categories than is at present orthodox in taxonomic circles, although it does not violate the International Rules of (Botanical) Nomenclature. It is doubtful if the categories here suggested are sufficient to cover all "natural groups" without sometimes forcing into the same "class" populations that are unlike in important and essential characters. Even if a very full survey of all existing "natural groups" that can be studied by the diverse methods of taxonomy, ecology, cytogenetics, and biogeography were made, and from the result a complete classification were made to cover adequately and without "lumping" all known living organisms, there would still remain a taxonomic problem of considerable magnitude. Evolution is not merely dynamic; it is, as shown in earlier chapters of the work under review, in the main a continuous process. Discontinuities, sometimes large, sometimes small, now occur in the products of evolution, but their 'reality', if the facts and conclusions of the first four chapters be accepted, is, with a minority of exceptions, of geologically recent date. If the fossil history of species, etc., be included in systematics, "the reality" of species (and of other taxonomic units) becomes a much more doubtful proposition and their classification correspondingly more difficult. It is, perhaps, not without significance that Huxley considers much of the fossil evidence, under the chapter heading "Evolutionary Trends", *after* he has dealt with speciation. It is, of course, arguable that it would be best to have two independent classifications—the one for extant organisms and the other for fossils. Neither would then be a general classification, complete to the limits of knowledge, and any proposal for such a dual classification, except as a tentative measure for special purposes, would appear antagonistic to the synthetic viewpoint taken by the author. The stress laid on the study of the discontinuities now occurring must be heartily welcomed and the author's discussion of this subject must surely focus research on a wide range of unsolved problems.

Dr. Huxley is a zoologist, but one with a very considerable knowledge of plants. The greater part of the evidence accumulated in "Evolution: the Modern Synthesis" is derived from studies of animals. There is, however, much botanical matter included in appropriate places. It is the fault of botanists themselves, or their fate, that relevant botanical material is not available for certain subjects. In particular, there is very little known about evolutionary trends in fossil series of plants, at least in comparison with the evidence available in certain invertebrate and some vertebrate groups. The chapter on "Evolutionary Trends" deals almost entirely with animal data. Again, ontogenetic studies in plants have been less successful in providing evolutionary suggestions than have ontogenetic studies in animals. On the other hand, it was from the study of plants that Mendelism arose, that mutations were first recognized and named, and that the importance of hybridization in evolution was first realized, perhaps because morphology and physiology have never been separated in botany to the extent they frequently are in zoology. Botanists will find the book of supreme interest from two general points of view: they will desire to add examples of evolution or inheritance, of structure or function, to the zoological and botanical examples given, thus supporting or modifying the conclusions reached by the author, and, secondly, they will obtain many suggestions, even from the more strictly zoological paragraphs, for investigation of plants from new points of view.

Every page causes one "furiously to think", not over obscurities of meaning, for the style is simple and clear and the vast majority of terms used will be known to any biologist, but over the actual facts set forth and the conclusions reached. Again, the very difficult feat has been accomplished of placing before the non-specialist scientific reader concise understandable accounts of recent important researches which were often difficult to follow in the original publications. The mathematical analyses of Fisher, Haldane, and Sewall Wright and the evolution of genetic systems are obvious, but not the only, examples. How the "layman interested in biology" will "find the book suited to his needs" must be decided by the layman. It would appear most definitely and admirably to meet the need of a very wide range of biologists for a synthesis of modern evolutionary fact and theory. W. B. TURRILL.

CHILD PSYCHOLOGY

The Natural Development of the Child

A Guide for Parents, Teachers, Students and Others. By Dr. Agatha H. Bowley. Pp. xvii+172+32 plates. (Edinburgh: E. and S. Livingstone, 1942.) 8*s*. 6*d*. net.

THIS small book is timely. The struggle to obtain recognition of the child guidance clinic as a necessary part of the educational system of Great Britain (and as part of preventive social medicine) is drawing to an end. It has created a need for easily accessible, readable and compact literature on the subject. Some need a general description of the work of a clinical team, while others ask for a text-book. Dr. Bowley's book does not meet either of these needs at all completely (and it was not her aim to satisfy them), but both classes of potential readers will find it very useful. The author has drawn upon a rich personal experience and upon wide reading, providing us with a very clear and concise summary of her knowledge. Her views are based upon the facts she knows so well, and her judgment remains independent.

The contents of the book necessarily range beyond the limits suggested by the title. The purpose is to describe the normal development of children, but since this cannot be achieved without comparison with abnormal variants, much of the book is concerned with pathological symptoms with suggestions for their treatment. The basis of the treatment is, however, the study of the normal child. The author describes the successive stages of child life briefly, but very clearly, very properly giving the pre-school child a large share of her space. She states the developmental norms which have been established by research workers briefly and usefully, and she could scarcely have done this better within such narrow space, but as Dr. MacCalman points out in the foreword, norms for the development of personality are much more difficult to establish than those for intellectual processes. This point is insufficiently stressed, and readers without experience in this field may be led to suppose that the checking up of general development is a more simple and certain procedure than it is. The standards the author mentions require careful interpretation based on a background of wide knowledge and experience. Teachers have this background, and to them the book can be recommended without reserve. It should prove exceptionally useful in training departments. But ordinary parents without specialized training (and with little opportunity of comparing children) need to be very cautious, though they can learn usefully from it. We hope they will not be induced to watch the stage by stage development of their children too closely or too anxiously. A few illusions about our sons is no great handicap to their upbringing.

The one demerit of the book is due to its small size. It is impossible to deal adequately with so wide a subject in 168 pages, and Dr. Bowley's desire to be comprehensive causes her statements to appear arid and dogmatic. The bibliographies provided would have been much more useful had there been space for fuller discussion in the text. Probably war-time restrictions have affected the scale of the volume, but if so it would have been better to buy more room for discussion and case-histories by sacrificing the plates, for charming as they are they add little to the information given in the text. So the book will be most useful if regarded as a very good notebook, and if used side by side with such a book as "A Survey of Child Psychiatry" (edited by R. G. Gordon, Oxford, 1939) both will gain in value.

A. W. WOLTERS.

A NIGERIAN KINGDOM

A Black Byzantium

The Kingdom of Nupe in Nigeria. By Dr. S. F. Nadel. (Published for the International Institute of African Languages and Cultures.) Pp. xv+420+16 plates. (London, New York and Toronto: Oxford University Press, 1942.) 25*s*. net.

SOME forty-five years ago, while the eyes of Great Britain were fixed on South Africa, Sir Frederick (now Lord) Lugard was quietly taking up the task of bringing ordered government into Northern Nigeria. This vast territory then consisted of a network of States under Muhammadan rulers who acknowledged the suzerainty of the Fulani Sultan of Sokoto. These States had attained a remarkable degree of political and military organization; but, as the social and economic system was based on slavery, this organization had been used to devastate the pagan tribes in a perennial hunt for slaves. When Sir Frederick Lugard assumed control in 1900, on behalf of the British Government, Northern Nigeria was in a state of complete chaos. To-day it is one of the most contented and prosperous portions of the British Colonial Empire.

Among the most powerful of the States forming the Fulani confederacy was the kingdom of Nupe. Situated on the Middle Niger, this State had been a thorn in the side of the Royal Niger Company, carrying out slave-raiding expeditions, sometimes to within a few miles of the Company's trading stations. In 1897 the Company had to send a military expedition against Bida, the capital city of the Nupe. The Nupe army was defeated and the Emir or Etsu, Abubakr, was driven out. But as soon as the British troops had retired Abubakr returned and resumed his defiant attitude. In 1901 Sir Frederick Lugard was compelled to take military action for the second time, Abubakr again fled, and was replaced by a prince named Mohamadu, who, like many of the other Fulani rulers of Nigeria, became a loyal supporter of the British regime. The day before his death, in 1916, Mohamadu told the writer of this review that the secret of the friendly acceptance of British rule by the peoples of Northern Nigeria was the consideration which had been shown from the outset to native institutions, and in particular to the Muhammadan religion.

The present volume, "A Black Byzantium", is a description of the Nupe kingdom, viewed mainly from the political and economic side. It is the work of Dr. Nadel, now the Government anthropologist in the Anglo-Egyptian Sudan. Dr. Nadel spent two years (1934–36) in Nupe, working as a Rockefeller fellow under the auspices of the International Institute for the Study of African Languages and Cultures, of which, incidentally, Lord Lugard is the distinguished chairman. He brought to his task a thorough knowledge of the technique of scientific investigation and soon established close and friendly relations with the Nupe, helped by his speedy mastery of their difficult language.

The Nupe people are far from being a simple or 'primitive' people. Indeed, the cultural differences within the tribe are so considerable that one of Dr. Nadel's principal difficulties was to discover representative sections. It was mere chance, he observes, that brought to his knowledge the discovery that in one small village there was a matrilineal system of succession to chieftainship, although Nupe society is conspicuously patrilineal, while in another village he stumbled on a ritual which amounted to a symbolic 'king-killing'—a usage for which there is no parallel in any other part of Nupe-land.

Chapter 2 deals with culture, tribe and society; Chapter 3 with the kinship system; and Chapter 4 with the general community, the pattern of whose life in the villages is very different from that in the towns. Then comes a close examination of the political organization. Nupe was a feudal State, divided into smaller and larger districts each administered by a feudal lord. These lords lived at the capital and rarely visited their possessions, but were responsible to the king for law and order in their districts. The fiefs were attached to certain offices or titles, and one of the weaknesses of this system was that promotion to a higher rank involved a re-shuffling of the fiefs. Besides these feudal lords there were numerous other titled officials, and included in the hierarchy were the heads of the craft-guilds, whose incorporation was a corollary of the control exercised by the State over all the more important industries. The king himself enjoyed many economic privileges, and one of these was the monopoly of the trade in kola-nuts, which are famous all over West Africa.

Slavery in Nupe-land carried with it no great stigma. Slaves, indeed, could rise high in the service of the king and might own lands or even fiefs. Another feature of Nupe society was the institution of clientship—the voluntary allegiance of a free individual to some feudal lord or other influential personage, with the view of securing his patronage and protection. Such a relationship involved on the client's part gifts, services and a regular tithe, and on the part of the protector help against claims, just or unjust, grants of land, and assistance in numerous other ways. Nupe society, indeed, was built up on a basis of class distinction. The prerogatives of the nobility were many and extended even to matters of dress, so that no commoner would dare carry a sword or wear a blue turban. In these decadent days there is a new symbol of social status—an alarum clock carried in a wooden case by the body-servants of men of rank!

Chapter 10 gives a description of government in modern Nupe. This proceeds on the general principle of indirect rule, and when Dr. Nadel says that agreement between the Etsu (king) and the British district officer is necessary for every administrative measure he must mean for every measure of major importance. A disturbing fact that emerges from Dr. Nadel's study of family budgets is the very heavy burden imposed on the poorer classes by the Government tax, small as it appears to be. The system, too, of collecting tax on an individual basis ignores the fact that the primary social unit of the Nupe is the large extended family—a co-operative body in which the poorer members are helped by the wealthier. Again, in the realm of law, there are the difficulties caused by the application of dual systems—the Muslim Sharia and the traditional law of the Nupe. Under the former, for example, property and land left by a family head are divided equally among sons—a practice which in Nigeria, as elsewhere in the Muhammadan world, has led to an excessive fractioning of the land. But under the indigenous system land and other property are inherited by a younger brother—the sons staying on the land and working with the brother's sons under the heir as their sociological father. In this way landed property is kept intact.

Coming now to economics, there is a lot of valuable information about the land-tenure system, although it is not always clear whether the writer is referring to past or present conditions. Land is freely borrowed, there are long-term leases, purchase, and primary and secondary tenantships of hereditary land. It may be observed that in Nigeria as a whole there is need of a great deal more information about native systems of land tenure. Little is known, for example, about the relations of landlord and tenant, the extent of sales, and so on. The land policy of Northern Nigeria has always been regarded as a model for other Colonies, and it has worked well in practice, so far. Yet where all lands are declared to be native lands and are also at the disposal of the governor, it is not clear what exactly is the legal position, especially since native custom regarding land tenure is in a state of rapid transition.

Dr. Nadel provides a great deal of information about agricultural production, the organization of labour, the various forms of collective labour, and the part played by women in the marketing of crops. Of particular interest are the descriptions of the guilds of blacksmiths, beadmakers, weavers and glass workers. There are chapters also on industria labour, wealth and other economic subjects. The book concludes with an account of the system of education for citizenship.

Dr. Nadel has an excellent command of English although he occasionally gives vent to bursts of jargon, as when he speaks of "an ideology heedless of empirical facts supplying the conceptual background for a social configuration"! There are also some historical slips. The dates of Etsu Mohamadu and Etsu Bello are wrongly given. Altogether "A Black Byzantium" is a most valuable contribution, particularly, on the economic side, to the much needed wider knowledge of Nigeria.

C. K. MEEK.

SYNTHETIC RUBBER

Modern Synthetic Rubbers
By Dr. Harry Barron. Pp. viii+274. (London: Chapman and Hall, Ltd., 1942.) 25*s.* net.

THE very title of the book is unacceptable to the technical mind: one speaks of "Hymns Ancient and Modern" and "Modern Furniture" but not of "modern" synthetic rubbers or indeed of any "modern" technical products. After reading the book the author's preface will be found most illuminating; for example, he states, "I have endeavoured to bring together as much of the information available in as palatable a form as possible", yet in so doing the author has written a book which is too technical for the general reader or even the average rubber technologist and too inaccurate for those seriously interested in synthetic rubber. Such statements, which occur frequently, as "Polyisobutylene is a polymer of isobutylene" are meaningless to the layman and redundant to the chemist. Some errors will be detailed below; they would appear to have arisen in two ways: first, by repeating existing published errors and, secondly, by the evident anxiety of the author to fill up gaps in existing knowledge. In some cases the author is actually in conflict with himself; for example, on p. 175 the reader is told "the first commercial synthetic rubber was neoprene", but on p. 214 the reader is asked to revise his views since: "The first commercially synthetic rubber to appear on the American market, was an ethylene polysulphide polymer designated as Thiokol". Another example is that on p. 201 the reader is informed that polyisobutylene has the greatest temperature range of elastic properties, but on p. 208 he is told that this record is held by butyl rubber.

Another somewhat regrettable feature of the book is one which the author has again deprecated in his preface, namely, the synthetic versus natural rubber controversial attitude, which may be all very well in technical journalism, a field in which the author is a recognized personality, but is undesirable in what purports to be a serious text-book. The solution to this controversy will be settled by hard technical and economic facts and not by political and journalistic pleadings.

In the chapter on the economics of synthetic elastic materials the author states that there has been considerable rivalry in the United States between petroleum interests, chemical interests and rubber manufacturers for leadership, but in fact the rivalry has been between the petroleum and agricultural interests over the raw material for butadiene. This has now been settled by allocation. It was generally recognized from the commencement of the campaign that the bulk of the polymerization work would be carried out by the rubber manufacturers, whereas the butadiene would be produced by petroleum and agricultural interests and 'second monomers' by the chemical and to a lesser extent by the petroleum interests.

Another curious characteristic of this book is that while the author bewails the almost entire absence of technical prowess in natural and synthetic rubber in Great Britain he fails to give credit to British work where it is due; for example, on p. 186, the use of chlorinated rubber for bonding neoprene to metals is attributed to Yerzley, but in fact it was discovered in Great Britain by Habgood. After reading p. 121, the conclusion would be reached that the pioneer work on the constitution of copolymers had been carried out in the U.S.S.R., since no mention has been made of the work in Great Britain of Hill, Lewis and Simonsen.

One of the greatest mistakes in the book is the failure (p. 70) of the author to realize that the discoverer of synthetic dyestuffs was not the same Perkin as the one that attempted to develop synthetic rubber in Great Britain in 1912, but his father.

In the general discussion of the relative merits of natural and synthetic rubber two important generalizations have been missed, namely, that natural rubber is superior to all synthetic rubbers in cutting and tear-resistance, and that the superior resilience of natural rubber is only true at normal room temperatures.

The author puts forward a terminology which he states to be simple and conforming to current practice. It is not simple because many of the products could be equally well put in two or more groups; thus 'butyl rubber' could be an 'elastomer' since it is based partially on butadiene, or an 'elastene' because it is based partially on an olefine, or an 'ethanoid' because butadiene is divinyl. Current practice is to call all these products collectively synthetic rubbers (since, as pointed out by the author, it is the properties, and not the product, which are desired) and individually by their trade names.

Many now generally recognized erroneous ideas are given in the book as, for example, that rubber is the *trans* isomer of polyisoprene (p. 63) and that rubber is formed by polymerization of isoprene in the tree (p. 124). Several wrong ideas could be drawn from the chapter on "Emulsion Polymerisation"; for example, the author sets out to give the impression that this work was undertaken "to simulate the simple processing of nature" whereas it was an inevitable development based on the rapidly developing field of physical chemistry with its growing knowledge of surface action and emulsification. The author regards emulsion polymerization as the solution of all polymerization difficulties and his love of false analogies has carried him into stating: "The position is roughly analogous to the change-over from wild uncultivated natural rubber to the carefully graded pleasant [!] plantation rubber of to-day", whereas those who have had any experience of emulsion polymerization know (a point emphasized by Carothers) that the control of this type of reaction is far from perfected. The author has also mixed up the Russian synthetic rubbers thus: on p. 70 he states that *SKB* is made from alcohol whereas on p. 142 he makes the assertion that it is made from petroleum.

The section on butyl rubber displays a lack of knowledge of the design and polymerizing conditions for this important group of rubbers. The sentence on p. 205, "An aliphatic iso mono-olefine such as isobutylene and a hydrocarbon compound having a conjugated system of alternate single and double bonds and having at least one olefine linkage, e.g. butadiene, isoprene, or styrene, are treated. . . ." is meaningless (and inaccurate) in a text-book. Furthermore, the author apparently is under the impression that isobutylene and butadiene will copolymerize in almost any proportions in which the experimenter mixes them, but this is, of course, not the case. Butyl rubber is described as a white material but no mention is made of the fact that the whiteness is due to zinc oxide put in by the manufacturer.

Some inaccurate information is given about the composition and constitution of the common commercial synthetic rubbers. How can, for example, "the basic recurring group" (p. 34) of a simple copolymer containing 25 per cent of one monomer contain one molecule of each monomer ? The suggestion is made (p. 177) that the superiority of Neoprene *G* over Neoprene *E* is due to its production by emulsion technique, but the fact is overlooked that Neoprene *E* was also eventually made by the same technique. Thiokol *F* is not derived from dichlorethyl formal (p. 216). The section about Hycars is confused and the uninformed reader might assume that importance is attached to Hycar *OR* for tyres. The section on Chemigums is equally indefinite and would lead the reader to believe that these rubbers had no similarity with Buna *S* or *N*. There are also several errors in the simple technology of the rubbers; for example, the statement is made on p. 206 that butyl rubber is difficult to work on a cold mill but becomes soft and smooth and amenable between 80–100 degrees (no scale of temperature given), whereas anybody who has ever handled this product knows that it runs smoothly on a cold mill but 'breaks' up on a hot one. On p. 59 the statement is made that a solution of chlorinated rubber is invariably employed for bonding synthetic elastic materials to metal. This is far from the truth, since with the sulphur-curing synthetic elastic materials the brass-plating technique is almost invariably employed.

In defence of the author it must be said that he has attempted to write about the subject at the most difficult time in its history, when products and ideas are changing and few technologists in Great Britain have had the opportunity of actually handling the new synthetic rubbers.

The general lay-out is good and it is a great pity that the book has been spoilt by so many mistakes.

W. J. S. NAUNTON.

THE HIGH-SPEED COMPRESSION-IGNITION ENGINE

The High-Speed Compression-Ignition Engine
By C. B. Dicksee. Pp. xii+331. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1940.) 16*s*. net.

THIS is the work of an engineer who has been intimately connected with the application of high-speed compression ignition engines to public passenger vehicles over the whole fourteen years of this development. He has been responsible for the power units of the majority of London's oil-engined buses and nobody will question the high technical standard these have reached. Improvements are so gradual that they usually pass unnoticed by the public, but a comparison of the state of the atmosphere in a traffic block on a hot summer's day in, say, 1939, with that in 1929, indicates the progress in combustion efficiency, lubrication, etc.

In his book, the author, with this wide experience to support him, has wisely written from his own point of view. He has, of course, found it necessary to call on the work of others, but the reasoning throughout is original and most of the experimental data are the results of his own researches. Proceeding from a brief but adequate treatment of the available basic knowledge of the properties of gases and of the processes of combustion, he discusses the various problems of practical design in a very able manner, endeavouring always to interpret practical results in terms of fundamental knowledge. His work thus preserves a better balance between theory and practice than is often found in books on this subject.

Following his first three chapters, which deal, respectively, with the laws of gases, ideal cycles and combustion, he discusses the losses and limitations of the practical engine. In this chapter, among other good points, he gives suitable prominence to the 'practical ideal' curve of efficiency of Tizard and Pye, which marks a great step forward from the air standard cycle to which many writers continue to devote so much attention. This is followed by a useful chapter on volumetric efficiency and the air charge.

The next two chapters, dealing, respectively, with the processes of combustion and the air movement in the combustion chamber are the author's best. The discussion of the interaction of the variables which determine the course of the ignition lag and subsequent combustion is masterly, the section dealing with the function of air movement being exceptionally good. A minor point is that the later Cambridge experiments carried out by Wolfer, under Bird's direction, are not considered, the author referring, on pp. 111 and 198, only to Bird's early work on ignition lag.

The author, in the next chapter of twenty-three pages, discusses types of combustion chamber. This discussion, while always sound in its reasoning and of great interest, suffers from incompleteness : for example, the Junkers design is omitted, in spite of the practical success achieved in aircraft and over the whole range of oil engine practice, while the General Motors engine would also merit consideration. But lack of space may have been the reason for this. The author unfortunately prefers the term "pre-combustion chamber" to "designs with ante-chambers".

This chapter is followed by one dealing with the somewhat difficult subject of fuel injection. Here the author reveals a defect of his good qualities, since, in his desire to correlate his own observations with fundamental principles, he neglects to use other experimental evidence available in British publications. In dealing with processes in the piping, therefore, he is at his best when dealing with engine results of a direct kind, in which the practical value of his evidence is high.

The book concludes with a valuable chapter having the title, "Some Practical Results". The discussion of the measurement of mechanical losses is interesting, but in most engines the third method, namely, of extrapolating the curve of fuel per hour on brake mean pressure, leads to values that are too high. The author, however, correctly says "that there is no method which will give a really accurate measurement of the indicated horse power". Under the heading, "Future Developments", and, indeed, throughout the book, no real reference is made to two-stroke engines. While the author obviously does not wish to deal with such engines, a mention of this limitation might have appeared in the preface. But none of the minor criticisms offered affect the fact that this work is of quite exceptionally high standard and value.

S. J. DAVIES.

THE BEVERIDGE SECURITY PLAN

SIR WILLIAM BEVERIDGE'S report on social insurance and allied services* has already been widely discussed, and it seems desirable to put on record its main features. The report includes, in discharge of its first duty, a comprehensive survey of social insurance and allied services as they exist to-day in Britain. This survey, showing just what provision is made, and how it is made, for different forms of need, is set out in Appendix *B*. The picture presented shows that provision for most of the many varieties of need through interruption of earnings and other causes that may arise in modern industrial communities has already been made in Britain on a scale not surpassed and scarcely rivalled in any other country. In respect of limitation of medical services Britain's achievement falls seriously short of what has been accomplished elsewhere, and its provision for cash benefit for maternity and funerals and its system for workmen's compensation are behind other countries. Secondly, social insurance and the allied services, as they exist to-day, are conducted by a complex of disconnected administrative organs, proceeding on different principles, doing invaluable service but at a cost in money and trouble for which there is no justification. In a system of social security better on the whole than can be found in almost any other country, there are serious deficiencies; by closer co-ordination, the existing social services could be made at once more beneficial and more intelligible to those whom they serve and more economical in their administration.

In proceeding from this comprehensive survey to the second duty, that of making recommendations, Sir William Beveridge lays down three guiding principles. First, any proposals for the future, while they should use to the full the experience gathered in the past, should not be restricted by consideration of sectional interests established in obtaining that experience. Secondly, organization of social insurance should be treated as one part only of a comprehensive policy of social progress. Thirdly, social security must be achieved by co-operation between the State and the individual. In offering security for service and contribution, the State should not stifle incentive, opportunity and responsibility; in establishing a national minimum, it should leave room and encouragement for voluntary action by each individual to provide more than that minimum for himself and his family.

The plan for social security set out in the report is based on these principles. It uses experience, but is not tied by experience. It is a limited contribution to a wider social policy in which not only want but also those other giants on the road to reconstruction—disease, ignorance, squalor and idleness—are attacked. It is first and foremost a plan of insurance, a scheme of social insurance against interruption and destruction of earning power, and for special expenditure arising at birth, marriage or death. The scheme is based on six fundamental principles: flat rate of subsistence benefit; flat rate of contribution; unification of administrative responsibility; adequacy of benefit; comprehensiveness; and classification. Its aim is to make want unnecessary.

The proposals are set forth in detail because the principles underlying any practical reform can only be judged by seeing how they would work in practice, and also because if a plan for social security is to come into operation when the War ends or soon after, there is no time to lose in getting the plan prepared as fully as possible. The plan covers all citizens without upper income limit, but has regard to their different ways of life. In relation to social security, the population falls into four main classes of working age and two others, below and above working age. These four classes consist of employees, or persons whose normal occupation is employment under contract of service; others gainfully employed, including employers, traders and independent workers of all kinds; housewives, or married women of working age; and others of working age not gainfully employed. All these four classes will be insured for security appropriate to their circumstances, and all classes will be covered for comprehensive medical treatment and rehabilitation and for funeral expenses. Maternity grant, provision for widowhood and separation and qualification for retirement pensions will be secured to housewives by virtue of their husbands' contributions, while in addition to maternity grant, housewives who take paid work will receive maternity benefit for thirteen weeks to enable them to give up working before and after childbirth. All persons in the remaining three classes of working age will pay a single security contribution on a single insurance document each week or combination of weeks. In the first class the employer will also contribute, affixing the insurance stamp and deducting the employee's share from wages or salary. The contribution will differ from one class to another, according to the benefits provided, and will be higher for men than for women.

Subject to simple contribution conditions, all employees will receive benefit for unemployment and disability, pension on retirement, medical treatment and funeral expenses. Employers and other independent workers will receive all these, except unemployment benefit and disability benefit during the first thirteen weeks of disability. Those of working age not gainfully employed will receive all these except unemployment and disability benefit, but as a substitute for unemployment benefit, training benefit will be available for those in both these classes to assist them to find new livelihoods if their present ones fail. Unemployment benefit, disability benefit, basic retirement pension after a transition period, and training benefit will be at the same rate, irrespective of previous earnings, providing by itself the income necessary for subsistence in all normal cases. There will be a joint rate for a man and wife who are not gainfully occupied. Disability due to industrial accident or disease will be treated like all other disability for the first thirteen weeks; thereafter disability benefit at a flat rate will be replaced by an industrial pension related to the earnings of the individual, subject to a minimum and a maximum. After a period of unemployment, benefit will normally be subject to a condition of attendance at a work or training centre.

Pensions other than industrial will be paid only on retirement from work and may be claimed at any time after sixty-five for men and sixty for women, the rate of pension being increased above the basic rate if retirement is postponed. Medical treatment covering all requirements will be provided for all citizens by a national health service organized under the health departments, and post-medical rehabilitation treatment will be provided for all persons capable of profiting by it. A Ministry of Social Security will be established, responsible for social insurance, national assistance and encouragement and supervision of voluntary insurance, and will take over, so far as necessary for these purposes, the present work of other Government Departments and of local authorities in these fields.

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* Social Insurance and Allied Services. Report by Sir William Beveridge. (Cmd. 6404.) Pp. 299. (London: H.M. Stationery Office, 1942.) 2*s*. net.

All the principal cash payments will continue so long as the need lasts, without means test, and will be paid from a Social Insurance Fund, built up by contributions from the insured persons, from employers, and from the State. This is in accordance with the view that benefit in return for contributions, rather than free allowances from the State, is what the people of Britain desire, and that the money required should come from a fund to which the recipients have contributed and to which they may be required to make larger contributions if the fund proves inadequate. The scheme thus preserves the contributory principle, but it also involves a pooling of risks except so far as separation of risks serves a social purpose; there is no longer an admitted claim of the individual citizen to share in national insurance and yet to stand outside it, keeping the advantage of his individual lower risk, whether of unemployment or of disease or accident.

In this plan, which is in some ways revolutionary but largely a natural development, and could be put in operation in the immediate aftermath of the War, there are two features which call for particular note. First, it involves superseding the present system of approved societies giving unequal benefits for compulsory contributions—a system which is inconsistent with the policy of a national minimum, has disadvantages for insured persons and involves unnecessary administrative costs—although there is suggested retention of the association of 'friendly societies' with national health insurance on a new basis. Secondly, it involves superseding the present scheme of workmen's compensation and inclusion of provision for industrial accident or disease within the unified social insurance scheme, subject to (*a*) a special method of meeting the cost of this provision and (*b*) special pensions for prolonged disability and grants to dependants in cases of death due to such causes.

In the forty-five years of its existence, the present system of dealing with the results of industrial accident and disease has, the report concludes, contributed little or nothing to the most important purpose of all, restoration of the injured employee to the greatest possible degree of production and earning as soon as possible. Post-medical rehabilitation has only just begun to receive practical attention. Costs of administration are higher in relation to workmen's compensation than they need be or than they are in compulsory social insurance, while the system affords no complete security for the payment of compensation and fails to secure maintenance of necessary income.

On balance, the reasons for distinguishing between accident and industrial disease in any employment and other causes of injury outweigh the reasons in favour of complete uniformity. The report also maintains that there is a good social reason for taking a different line, in part at least, about the dangers of industrial accident and disease. Accordingly, one part of the funds required for benefits, pensions and grants in respect of industrial accident and disease will be obtained by a levy on employers in industries scheduled as having materially more than the normal risk of accident or industrial disease as a whole. The levy will not cover the whole of the excess cost above the normal but only a prescribed proportion, and will be based on wages paid and on the degree of risk, so that it can be raised or lowered as the risk in any such industry or in any particular place of employment is found to be above or below expectation.

Exactly what industries should be scheduled as hazardous is a matter for further detailed inquiry, but the report makes an additional important proposal in regard to the machinery of administration. It is suggested that, in each industry scheduled as hazardous, and liable to the special levy, there should be set up a statutory association of employers and employees to deal with the problem of industrial accident and disease. The functions of such an association might include the promotion of safety in the industry, by co-operation with the department or departments responsible for safety regulations, by research into the causes of accidents, by propaganda and instruction, and in other ways; the promotion of measures for rehabilitation and re-employment in that industry, in co-operation with the general national organs for that purpose covering all industries; advice on the making of all regulations affecting safety in the industry, the scheduling of industrial disease, and methods of assessment of earnings; collecting from individual employers their quotas of the total levy required in the industry, in accordance with a scheme to be prepared by the association and approved by the Ministry of Social Security; and the establishment of schemes to supplement the benefits statutorily secured to all injured employees.

The statutory associations should combine the management and the labour in each industry, and the main purpose of the proposal is, within the framework of general social security, to utilize the knowledge, initiative and interest of those concerned in each industry, first, in making it as safe as possible, and, secondly, in mitigating so far as is humanly possible the consequences of those accidents and injuries that defy prevention.

In regard to the administration of the scheme by a new Ministry of Social Security, the report contemplates the establishment of a Social Insurance Statutory Committee, of an advice bureau for citizens in every local Security Office, and of a Division of Statistics and Intelligence, under first-rate leadership and with adequate reserves, to make use not only of its own material but also of the experiences of other countries. The Ministry should be able to make grants for research in all matters where further knowledge might reduce the burdens on the Social Insurance Fund. Provision is to be made to prevent hardship to persons employed in the administration of the present insurance schemes who are displaced as a result of the changes and for whom suitable alternative employment is not available; but while social security under the new system will involve no great increase, if any, in the number of officials, it is unlikely to make large numbers of those now employed redundant at any early date.

The scheme involves three particular assumptions which are discussed in detail in the last part of the report. The first of these is a general scheme of children's allowances. Social insurance should be part of a policy of a national minimum, and a national minimum for families of every size cannot be secured in practice by a wage system which must be based on the product of a man's labour and not on the size of his family. The view is taken that children's allowances are essential if benefit during unemployment is not to be allowed to equal or exceed earnings during work. They should be non-contributory, provided wholly out of taxation, and not to any extent out of insurance contributions. Accordingly the report recommends that children's allowances should be provided at the cost of the Exchequer in respect of all children other than the first child when the parent is earning, and of the first child in addition during the interruption of earning. The actual allowance should be graduated according to the age of the child and a cash allowance of 8s. a week on an average, administered by the Ministry of Social Security, is suggested.

The second assumption is comprehensive health and rehabilitation services for prevention and cure of disease and restoration of capacity for work, available to all members of the community. This is in accordance with the definition of the objects of medical service as outlined by the Medical Planning Commission of the British Medical Association in its draft interim report. While no detailed proposals are advanced in the Beveridge report, it suggests the need for a further immediate investigation, in which the finance and the organization of medical services can be considered together, in consultation with the professions concerned and with the public and voluntary organizations which have established hospitals and other institutions. From the point of view of social security, a health service providing full preventive and curative treatment of every kind to every citizen without exception, without remuneration limit and without an economic barrier at any point to delay recourse to it, is the ideal plan. Accordingly it is proposed that the social security contributions shall include a payment in virtue of which every citizen will be able to obtain whatever treatment his case requires, at home or in an institution, medical, dental, or subsidiary, without a treatment charge.

In regard to rehabilitation, the report advances three general propositions. Rehabilitation must be continued from the medical through the post-medical stage until the maximum of earning capacity is restored, and a service for this purpose should be available for all disabled persons who can profit by it irrespective of the cause of their disability. Cash allowances to persons receiving rehabilitation services should be the same as training benefit, including removal and lodging allowances where required, and thirdly, the contributions paid by insured persons should, as with medical treatment, qualify them for rehabilitation service with further payment. The organization of the rehabilitation service is already under examination by the Ministry of Labour and National Service.

The third assumption, on which the whole report is based, is the maintenance of employment and the prevention of mass unemployment. Payment of unconditional cash benefits as of right during unemployment is satisfactory provision only for short periods of unemployment; after that, complete idleness even on an income has a demoralizing effect. The report proposes therefore that, after a certain period, unemployment benefit should be conditional upon attendance at a work or training centre. Not only is this proposal impracticable if it has to be applied by the hundred thousand, but also the only satisfactory test of unemployment, an offer of work, breaks down in mass unemployment. The probable and possible effects of the Plan for Social Security in stabilizing the demand for labour are among its advantages, but they are subsidiary and do not touch the main problem of maintaining employment. For that, other measures are needed, and unless such measures are prepared and made effective, much that otherwise might be gained through the Plan for Social Security will be wasted.

The Plan for Social Security thus advanced cannot be judged without reference to the concluding section of the report, in which the abolition of want as a practicable post-war aim is discussed. The rise in the general standard of living in Britain during the last thirty or forty years demonstrates, first, that growing general prosperity and rising wages diminished want but did not reduce it to insignificance, and, secondly, that it is wrong to assume that the present War must bring economic progress for Britain, or for the rest of the world, to an end. New measures are needed to spread prosperity, and the plan is designed to meet that need. Freedom from want, in Sir William Beveridge's view, can be regarded as a post-war aim capable of early attainment on four conditions: after the War the nations must set themselves to co-operate for production in peace, rather than to plot for mutual destruction by war, whether open or concealed; the re-adjustments of British economic policy and structure that will be required by changed conditions after the War should be made so that productive employment is maintained; a plan for social security, that is to say, for income maintenance, should be adopted free from unnecessary costs of administration and other waste of resources; and finally, decisions as to the nature of the plan should be taken during the War.

If a plan for freedom from want, so far as social security can give it, is to be ready when the War ends, it must be prepared during the War. The decisions required now are of principle and execution —the decision to introduce a unified comprehensive scheme of social insurance, the decision to entrust administration of the scheme to a Ministry of Social Security, and the decision to appoint some person or body to prepare the necessary legislation and bring the scheme into being, so that it is ready when the War ends. The plan is put forward as part of a general programme of social policy and as a contribution towards the achievement of the social security named in the fifth clause of the Atlantic Charter. The report makes the points that the purpose of victory is to live into a better world than the old world; that each individual citizen is more likely to concentrate upon his war effort if he feels that his Government will be ready in time with plans for that better world, and that if those plans are to be ready in time they must be made now. The proposals are a sign of the belief that the object of government in peace and in war is the happiness of the common man.

"Freedom from want," concludes the report, "cannot be forced on a democracy or given to a democracy. It must be won by them. Winning it needs courage and faith and a sense of national unity; courage to face facts and difficulties and overcome them; faith in our future and in the ideals of fair-play and freedom for which century after century our forefathers were prepared to die; a sense of national unity overriding the interests of any class or section."

ORIGIN OF THE CORONIUM LINES

By Dr. A. HUNTER

IT is now nearly three quarters of a century since the green line in the spectrum of the solar corona was first observed. Subsequent observations—few eclipse expeditions since then have neglected this field of study—have established that the inner corona emits a spectrum consisting of at least twenty-two broad bright lines superposed on a continuum. The brightest line is usually the green one at 5303 A., but considerable variations in the relative intensity of the lines are found from eclipse to eclipse, and recent coronagraph observations made without an eclipse confirm large day-to-day intensity variations. None of the lines have ever been produced in the laboratory, nor indeed have they ever been observed in any other celestial source, except for a brief appearance during a nova-like outburst by the variable star *RS* Ophiuchi in 1933. There has been no lack of suggestions regarding their origin: they have been attributed in turn to iron, to 'proto-fluorine', to singly- and doubly-ionized calcium, to argon, and to oxygen, neutral and ionized; all with a certain amount of supporting evidence, and the last three within the past fifteen years. None of these assignments has had general support, however, because none of them explains more than a small selection of the facts.

Early attacks on the problem of identification proceeded along the only lines then possible, namely, by seeking wave-length coincidences with known spectra. Many such identifications announced in the days of visual observations did not survive the stricter tests applied when photography made fairly accurate wave-lengths available. By the turn of the century it was decided that even the closer coincidences were due to chance, and that the mysterious lines could not be attributed to any known element. At this stage the emitting substance was named 'coronium', and the possibility that it was indeed a new chemical element was seriously discussed. After all, was there not a renowned precedent for such a discovery in the observation of helium on the sun nearly thirty years before its detection on the earth? With the gradual filling of the Periodic Table, however, this possibility grew less and less likely. The discovery which was perhaps its death-blow came in 1935 when 'nebulium', the hypothetical element responsible for a somewhat similar spectrum emitted by the gaseous nebulæ, was identified by Bowen in unexceptionable fashion as a mixture of ionized oxygen and nitrogen. After this it was accepted that coronium must be a familiar substance excited by some process which develops the coronal spectrum while completely suppressing the normal one.

The most hopeful line of attack when direct comparison with known spectra failed was to examine intercombinations between known term values; that is, to compare the observed frequencies of the coronal radiation with the frequency differences between known energy levels of likely atoms or ions. The transitions involved would probably be 'forbidden' (as in nebulium) or at any rate of low probability, otherwise they would have been observed in terrestrial sources; but this need not hamper the search, since the energy levels concerned may be known quite accurately from permitted transitions which involve them. The energy diagrams of many neutral atoms were already quite well known; well enough to decide forthwith that they would indicate only what coronium was not, not what it was. The next step was to extend the search to ionized atoms. In the past fifteen years the growth of our spectroscopic knowledge of these has made possible a systematic survey of the metastable states of ions which are likely to occur in the corona. The forbidden lines, with some of which, it was hoped, the coronal lines would be identified, are inward transitions from these metastable states, transitions which do not take place in normal conditions of excitation. Metastability will be favoured by the low pressure known to exist in the outer regions of the sun's atmosphere; in these conditions an atom, once it reaches a metastable state, will remain there long enough to get rid of its excess energy by a forbidden radiative transition rather than by a collision. But when some five years ago patient search among the forbidden lines to be expected in such ions as Fe II, Fe III, Ca II, Ti II, Ti III, A II and many others had failed to give any coincidences with the observed coronal lines, hope began to fade. It was pointed out that before the metastable ions could emit forbidden lines, the intense solar radiation permeating the corona should raise them to normal states, from which allowed transitions would give rise to the ordinary spectral lines of the elements concerned. That this widely accepted objection is not necessarily valid, however, and that the method of attack was probably on the right lines, will appear later.

At this stage opinion veered to the opposite extreme. Emphasis was placed on the great width of the coronal lines, which is not by any means a feature of the nebular lines identified with such success as forbidden lines. Line-widths of the order of angstroms indicate that the excited states involved have unusually short lifetimes—quite the reverse of metastability. It was accordingly suggested that double-electron excitation is occurring in the atom or atoms concerned. In this process, an electron belonging to the inner core, which remains undisturbed in the ordinary way, is removed to an outer orbit at the same time as an outer electron is excited. With different excitations of the outer electron the atom will be in energy states from which it can radiate a new series of lines quite different from its ordinary spectrum. In many of these states it possesses more than its ionization energy; its lifetime in such levels will be short, because spontaneous ionization converting it to a normal ion and an electron with kinetic energy will in general be possible. The probability of this auto-ionization at any level will determine the width of a line originating in that level.

Between 1933 and 1935 wide lines due to such inner-electron excitation were observed in the laboratory in the alkali metals, in zinc, cadmium and mercury, and in the rare gases. The temptation to draw an astrophysical parallel was strong, and in 1934 it was predicted[1] that this type of excitation in helium—a likely atom, since helium and coronium are known to co-exist in the upper chromosphere—will produce several diffuse lines in the visible region of the spectrum. Unfortunately, attempts[2] to produce the coronal lines in helium in the laboratory under conditions likely to favour two-electron excitation have not had the success which attended, for example, McLennan's search for the auroral green line in oxygen. The absence of ordinary helium lines from the coronal spectrum is also a troublesome point with this hypothesis. What is more disturbing, however, is that the great line-breadths, which are fundamental in the theory, may not be intrinsic at all: they could be due to some secondary process occurring after the emission of the lines. Turbulence will broaden the lines by the Doppler effect, for example, and Doppler broadening is particularly likely, for the equivalent widths of the lines are roughly proportional to their wave-lengths. It is significant here that velocities of 10 km./sec. in coronal arcs have been observed directly by Waldmeier[3] with the Arosa coronagraph; an average turbulent velocity of this order would widen lines, initially quite sharp, by nearly the required amount.

At the beginning of the War, then, the problem of the source of the coronal lines seemed little nearer solution than it was a decade before; and it looked as if this long-standing challenge to spectroscopists and astrophysicists would remain in abeyance until such problems could again be attacked. In a short paper[4] which has just reached Great Britain from Sweden, however, B. Edlén proposes a solution which is by far the most attractive yet put forward and which will command widespread support. His method is not different in essentials from the one outlined above, in which the emission is attributed to forbidden transitions from metastable states of ionized atoms; but he abandons the somewhat conservative approach hitherto adopted and boldly examines the metastable levels of atoms which have lost from nine to fifteen electrons. Matter in this high state of ionization can be produced in the laboratory by passing high-energy sparks between metal electrodes, the ionization stage being roughly controllable by varying the capacity and inductance of the electric circuit and the potential across the spark gap. High-capacity condensers ($\sim 0{\cdot}5\mu$F.) charged to 100,000 volts have been used for extreme excitation of this sort. The development of vacuum spectrographs using diffraction gratings at grazing incidence has made it possible to photograph the spectra of these ions, the ultimate lines of which lie so far in the extreme ultra-violet as to merit the description of soft X-rays rather than of optical radiation.

Analysis of the spectra so produced has been very largely due to Edlén, working in Prof. Siegbahn's laboratory at Uppsala, and this is by no means the first time that results of interest and importance to astronomy have followed from his work. In this connexion it is relevant to recall that in collaboration with Bowen he recently identified[5] nine lines in the spectrum of Nova Pictoris with forbidden transitions in Fe VII. He now attributes practically the whole of the coronal line spectrum to forbidden transitions in calcium (Ca XII and Ca XIII), nickel (Ni XII, Ni XIII, Ni XV, Ni XVI), and, especially, iron (Fe X, Fe XI, Fe XIII, Fe XIV).

Wave-length (A.)	Intensity		Identification		Ionization potental (eV.)
	Grotrian	Lyot	Ion	Transition	
3328·1	1·0		Ca XII	$^2P_{3/2}-^2P_{1/2}$	589
3388·10	16		Fe XIII	$^3P_2-^1D_2$	325
3454·13	2·3				
3600·97	2·1		Ni XVI	$^2P_{1/2}-^2P_{3/2}$	455
3642·87			Ni XIII	$^3P_1-^1D_2$	350
3800·77					
3986·88	0·7		Fe XI	$^3P_1-^1D_2$	261
4086·29	1·0		Ca XIII	$^3P_2-^3P_1$	655
4231·4	2·6		Ni XII	$^2P_{3/2}-^2P_{1/2}$	318
4311·5					
4359					
4567	1·1				
5116·03	4·3	2·6	Ni XIII	$^3P_2-^3P_1$	350
5302·86	100	120	Fe XIV	$^2P_{1/2}-^2P_{3/2}$	355
5694·42		1·5			
6374·51	8·1	28	Fe X	$^2P_{3/2}-^2P_{1/2}$	233
6701·83	5·4	3·3	Ni XV	$^3P_0-^3P_1$	422
7059·62		4			
7891·94		29	Fe XI	$^3P_2-^3P_1$	261
8024·21		1·3	Ni XV	$^3P_1-^3P_2$	422
10746·80		240	Fe XIII	$^3P_0-^3P_1$	325
10797·95		150	Fe XIII	$^3P_1-^3P_2$	325

An observation by Grotrian[6] that the wave-numbers of the coronal lines at 6374 A. and 7892 A. coincide with the doublet separations in the ground terms of Fe X and Fe XI first suggested to Edlén a search for analogous term separations in other ions. This led immediately to the discovery that two other strong lines coincide with the corresponding term separations in Ca XII and Ca XIII (see the accompanying table, which is taken from Edlén's paper). No other coincidences with known term differences have been found (largely, no doubt, because the spectra of atoms in such high stages of ionization are as yet very imperfectly analysed), but this early success in classifying four strong coronal lines can scarcely be due to chance. This being so, Edlén proceeds on the assumption that the whole coronal spectrum consists of forbidden lines of atoms in higher stages of ionization than have hitherto been considered. Enough is known from his own work on the extreme ultra-violet spectra of vacuum sparks to make it possible to extrapolate with reasonable accuracy along iso-electronic sequences, and so to obtain estimated term separations in ions for which term analyses are imperfect or even lacking altogether. Judging by the intensity of Fe X and Fe XI, he argues, iron is apparently present in abundance; yet the Nova Pictoris lines of Fe VII are not present in the corona. The reason for their absence is suggested by the presence of Ca XII and Ca XIII: evidently the excitation level in the corona is too high for Fe VII to appear. This immediately suggests a search for Fe XII, Fe XIII, Fe XIV, Fe XV, Fe XVI and Fe XVII. Examining these, he finds that the extrapolated term-differences in the first ion are not observable astronomically, while the last three have no deep metastable levels. This leaves Fe XIII and Fe XIV, and it is of great significance that the extrapolated ground-doublet separation in Fe XIV points unmistakably to the famous green line at 5303 A., while the next strongest lines, including the infra-red ones discovered by Lyot, correspond to the Fe XIII transitions given in the table. These identifications with term differences in iron atoms from which 9, 10, 12 and 13 electrons have been removed dispose of more than 90 per cent of the coronal emission, when the line intensities are taken into account.

On the assumption that these classifications are correct, we are now on firm enough ground to extrapolate further to elements close to iron in the Periodic Table. Examination of the iso-electronic ions of nickel shows that analogues of all except one of the transitions already identified in iron appear among the observed coronal lines; and the missing nickel line is not in the accessible wave-length range. This accounts for six more lines, the intensities of which are roughly one-tenth that of the corresponding iron lines; this ratio agrees well with the usual relative cosmic abundance of these elements. Thus all except about three per cent of the coronal line emission can be attributed to forbidden transitions in highly ionized calcium, iron and nickel.

It is encouraging that the proposed identifications classify the various lines in a way which agrees well with Lyot's grouping of the coronal lines by their intensity distribution round the sun. In particular, the marked differences in physical behaviour pointed out by Waldmeier between the green line at 5303 A. and the red one at 6374 A. are no doubt connected with the very different excitation needed for the production of the two lines. It is important, of course, to examine the problem of coronal emission as a whole, and not to be content with a series of positive identifications, however satisfactory. What of other constituents of the sun's outer atmosphere ? Atoms of potassium, chromium, manganese and cobalt, which have strong lines in the ordinary solar spectrum, might be expected to show some evidence of their existence in the corona, since observable lines are predicted in the spectra of their ions at the appropriate ionization level. That they do not is attributed by Edlén to low abundance in the corona ; and he makes the suggestive remark that meteoritic matter is rich in iron and nickel (in about the abundance ratio suggested by the relative strengths of their lines) but not in potassium, chromium, manganese or cobalt. All the other elements well represented in meteorites (oxygen, magnesium, aluminium, silicon and sulphur) have ions which do not give rise to strong lines in the observable range.

Turning now to the physical conditions required by Edlén's proposals, the most striking fact is the enormous energy required to strip the atoms of iron, nickel and calcium of so many electrons. In this connexion it is perhaps significant that Lyot, in order to account for the width of the coronal lines by pure thermal motion, found that a temperature of 660,000° K. would be needed if the emitting particles were as heavy as oxygen atoms. Recalculating to iron atoms, 3·5 times heavier, a coronal temperature of 2,300,000° K. must be postulated ; and at this temperature an atom in thermal equilibrium with its neighbours will have an average translational energy of more than 300 electron volts. What may be the physical meaning of a coronal 'temperature' of more than two million degrees is as yet unknown, but it may be recalled that many solar and extra-solar phenomena demand excitation far higher than that provided by total radiation of 6,000° K. quality. The excitation of hydrogen and especially of helium in the chromosphere and prominences, the production of the 'twilight flash' spectrum of $N_2{}^+$ in the earth's upper atmosphere, the ionization of carbon monoxide and nitrogen molecules in comet tails by solar radiation, and the production of *D*-region ionization in the ionosphere by bright eruptions on the sun may all be classed as super-excitation processes indicating solar 'temperatures' ranging from 10,000° K. to 20,000° K. in the ultra-violet.

No other known phenomenon, however, requires such a tremendous input of energy to the atoms in the solar neighbourhood as Edlén's proposed mechanism, though of course this is not an argument against the validity of his theory. The objection originally raised to hypotheses of this type, namely, that metastable atomic states cannot persist long enough in an intense radiation field to give rise to forbidden lines, cannot be urged against the new identifications, for the ultimate absorption lines of these highly ionized atoms are in the soft X-ray region, where presumably the sun does not emit a great deal of radiation. The particles will therefore be as little disturbed by radiation as by collision, and can emit lines which are normally forbidden. A point in favour of the theory is that it accounts for the presence in the inner corona of large numbers of free electrons, which will scatter sunlight and so give rise to the faint continuous background of the emission lines.

A difficulty is encountered, however, if the doubling observed in 5303 A. by Waldmeier[8] is really due, as he suggests, to self-reversal. In this process, a narrow absorption line is superposed on a broad emission line, thus producing an apparently double line. The phenomenon is of common occurrence in certain sources such as laboratory arcs and the sun itself, where hot emitting particles are surrounded by an envelope consisting of similar but cooler particles. But not all lines can show self-absorption, and we know of no physical conditions compatible with those likely to exist in the corona which can produce absorption of forbidden lines. The difficulty is not insuperable, however, since other causes can produce doubling of lines ; the need now is for more observations to distinguish between the various possibilities.

Qualitative support is lent to the new theory by certain observations of novæ. In these objects an outburst of energy is believed to be followed by the ejection of a shell or a series of shells of matter, the central star being soon surrounded by an extended low-pressure atmosphere which might on general grounds be expected to behave rather as the solar corona does. It is thus significant that, as mentioned above, forbidden lines of Fe VII have been identified with certainty in the spectrum of Nova Pictoris, and that some of the coronal lines themselves have appeared in Nova Ophiuchi. That the coronal spectrum is such a relatively inconspicuous part of the radiation emitted by the sun, whereas forbidden lines are often very prominent in nova spectra, is thus probably a difference of degree rather than of kind. We can never hope to detect the coronal spectra of other stars unless their envelopes become major structural features by some such outburst as this. The important point is that the coronal lines are produced in conditions which favour the emission of forbidden lines in highly ionized iron.

The future of the theory, it may be surmised, lies partly in laboratory experiment and partly in astronomical observation. While only four lines can be described as directly identified, the theory can scarcely be regarded as established, especially when it is remembered that there is an inevitable loss of precision in working from short-wave measurements through frequency differences to wave-lengths in the visible region. However, the number of well-established term analyses of highly ionized atoms is already considerable, and it is unlikely that Edlén's extrapolations are too daring, though unfortunately he gives no estimate of his error of prediction. What is needed now is a thorough analysis of the ultra-violet spectra of Fe XIII, Fe XIV, Ni XV, and Ni XVI. It is most unlikely that the coronal lines can yet be reproduced in the laboratory, since to keep these stripped atoms in metastable states for times of the order of a second is quite beyond our present technique ; but a definitive energy-level analysis obtained from the permitted ultra-violet lines would provide conclusive evidence and should not prove impossible with present means of attack. Meanwhile, coronagraph observations such as those projected by Lyot and Waldmeier will give valuable auxiliary information ; and a critical re-examination of past eclipse spectrograms, carried out in the light of their recent results, would probably be extremely useful.

On the theoretical side the position is rather different. Here it must be admitted that the new suggestions are in advance of solar physics. But their somewhat startling nature need occasion no surprise: other suggestions along more conservative lines have been so thoroughly explored that something out of the ordinary was to be expected. The immediate reaction of most astronomers will no doubt be one of incredulity that such highly ionized matter as Edlén's proposals call for should exist in the outer envelope of a relatively cool star like the sun. But this is not altogether a valid objection: if the lines can be satisfactorily identified, then our ideas concerning the conditions existing in the solar corona must be modified. Twenty years work has been done on this problem by physicists whose horizon has been tacitly limited by the astronomers' conception of coronal conditions; if, where they have failed, a solution which ignores this conception proves otherwise acceptable, then astronomers will welcome the opportunity of enlarging their ideas, and solar physics will benefit accordingly.

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THE HONEYBEE

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FROM the beekeeper's point of view, honey production is the main object of beekeeping; but from the national point of view it is only a by-product. Both in peace and war, the chief contribution of beekeeping to the national economy is the provision of pollinators for crops such as fruit, clover and mustard. Except for this fact it is doubtful whether the allocation of 15–20 lb. of sugar per annum to each colony could be justified, even though in an average season an average surplus of 30–35 lb. of sugar (as 'honey-sugar') should be obtained over and above the 20–25 lb. of honey which should be left in the hive in the autumn for the use of the bees during the non-productive months of the year. Recent estimates show there to be nearly 56,000 beekeepers, owning a total of about 430,000 colonies of bees, in England and Wales alone, but the allocation of some three or four thousand tons of sugar to them annually is a small price to pay for successful fruit and seed crops.

At a symposium on the honeybee organized by the Association of Applied Biologists, on December 4[1], Mr. C. G. Butler showed figures indicating that in such cold spring weather as that of 1941, honeybees were almost the only pollinating insects present in orchards in which comparative counts of pollinating insects were made, and the view was expressed that they were responsible for a high proportion of the fruit set. It was further pointed out that there is good evidence that in those areas where large orchards and acreages of seed crops are being grown there are often insufficient wild pollinating insects present for full production to be obtained. Quite apart from this crowding effect of crops upsetting the natural balance between pollinators and flowers requiring pollination, intensive cultivation has resulted in destruction of the nests and habitats of many wild pollinating insects.

It is greatly to be regretted that British growers have not yet fully realized the value of honeybees as pollinators the numbers and location of which can readily be controlled. Many countries are much more advanced in this respect and recognize that the honeybee is almost certainly the most important pollinating insect.

The small 'back-yard' beekeepers, scattered throughout the length and breadth of Britain, play a most important part in providing the necessary pollinating insects. There is no evidence, however, of any marked concentration of beekeeping in the predominantly fruit-growing areas.

It has recently been estimated that the approximate cash value of the honeybee to the nation as a pollinator of fruit crops alone is £4,000,000 per annum, and an average of about £1,250,000 worth of honey is produced annually.

In order to make the best use of honeybees for the pollination both of hard and soft fruit and of many important seed crops, the bees must be well kept and healthy, and suitably managed and placed for the crop in question.

A recent survey was designed to discover the distribution of diseases of the adult bee, particularly with respect to acarine disease, the complaint which was almost certainly largely responsible for the extermination of more than 90 per cent of all the colonies of honeybees in Britain about the time of the War of 1914–18. The results show that it is a fair assumption that at least one colony in every five in England and Wales was suffering from this complaint last winter. Steps are now being taken to make beekeepers more 'disease conscious'. Since satisfactory treatment for acarine disease is now known there is no reason why this complaint should not be brought under control.

The position with regard to other diseases of the adult bee is not nearly so serious in Great Britain, although such diseases are only too prevalent on the Continent.

The other diseases of the honeybee which are a serious cause of concern at the present time are two diseases of the brood, European and American foul brood, usually known collectively as foul brood. Of these the commoner is American foul brood caused by the bacterium, *Bacillus larvæ*. This disease is both widespread and common in England and Wales. No cure, in the true sense of the word, is known for either of the kinds of foul brood, but American foul brood can be eliminated from a colony by the careful use of methods designed to separate the bees from their brood and honey. Such methods, however, require extremely careful application and, for this reason, as pointed out by Mr. P. S. Milne, should only be applied to strong colonies which are really worth saving, and then only under the supervision of experts. A great deal of valuable work in combating foul brood has been carried out by Bee Disease Insurance, Ltd., which is operated as a 'friendly society', but experience has shown that there are a small number of cases of foul brood which, on account of apathy or selfishness on the part of the owners of the apiaries concerned, could not be reached by any voluntary organization. The Foul Brood Disease of Bees Order, 1942, was put into operation in March 1942 in order to deal with those cases where a beekeeper whose apiary is believed to be serving as a potential source of infection refuses to co-operate with any such voluntary organization. During its first season of operation several hundred cases have been dealt with under the Order.

Concurrent with the gradual realization of the value of the honeybee as a pollinator and its use for this purpose in many orchards, complaints of the poisoning of honeybees by insecticidal and fungicidal sprays have increased. Despite certain ill-informed statements in the Press, spray poisoning of honeybees in Great Britain is in no way comparable with the position in certain States in America, but the matter is sufficiently serious to warrant careful investigation.

As pointed out by Mr. G. A. Carter, the ingredient in the more usual spray mixtures which has been found to cause poisoning of honeybees is lead, or calcium, arsenate; the small dose of 0·00005 mgm. of arsenic being sufficient to kill a bee. This substance, contrary to statements sometimes made, is no more attractive to the honeybee than distilled water, and is only taken by the honeybee by accident either when seeking water from the foliage and trunks of sprayed trees or when collecting pollen from flowers, either from the trees themselves or from weeds growing near the trees on to which the spray has drifted. Only some ten or a dozen apiaries have been reported as being affected in each of the last three years, although it should be noted that detection is not simple since, when poisoning from drip water occurs, the majority of the foraging bees die in the field. Only when contaminated pollen is collected is serious poisoning of the brood likely to occur. The spraying of open blossom with washes containing arsenic should be avoided whenever possible. Not only does such poisoning harm the beekeeper but also, since about 90 per cent of the bees working an orchard are on the trees at any given time on a good flying day, the grower is likely to lose a high proportion of his pollinating insects immediately.

The use of deterrents to keep bees away from arsenical washes is receiving consideration in the Bee Research Laboratory at Rothamsted Experimental Station. In laboratory trials, discussed by Mr. D. J. Finney, lime-sulphur and nicotine sulphate in the strengths usually employed in spray mixtures both acted as strong repellents to the honeybee, provided an adequate source of uncontaminated food was present at the same time. This suggests that compound sprays incorporating these substances are not very likely to cause poisoning of honeybees in the field, provided that sprays are not applied to open blossom. No absolute deterrent has so far been discovered and the spraying of open blossom with arsenical sprays, even though they contain lime-sulphur or nicotine sulphate, is likely to harm bees.

The observation of Minderhoud that a foraging honeybee confines its attention to a relatively small area, usually 4–5 yards in diameter, of a crop in which nectar is abundant, has been confirmed by Messrs. Butler, Jeffree and Kalmus at Rothamsted Experimental Station. The honeybee does not wander over a crop at random. However, if a sufficient force of field bees is present, a population of wandering bees is superimposed upon this fixed population. It can be shown that this wandering population is composed of a few old bees driven on by competition and of a large number of young bees which have not yet become fixed to any particular area of the crop in question.

It is this wandering population, superimposed upon the fixed population, which is of value to the fruit-grower in obtaining cross-pollination of his trees; and it appears probable that many of the cases of apparent failure to increase crops by the use of honeybees as pollinating agents is attributable to the use of an insufficient force of field bees. It is suggested that the force required can be determined over a number of years by placing the pollinating colonies together in the centre of the orchard concerned and noting the set of fruit. If an insufficient force of bees is present, other things being equal, the greatest set will be found near the hives and will decrease progressively outside this zone of competition. When an even set of fruit has been obtained throughout the orchard the force of bees is probably correct. Competition between trees and weeds must also be avoided. In many plum orchards dandelions and other weeds produce such competition, and cause neglect of the trees in favour of the weeds.

The problem of the producer of pure seed is somewhat different from that of the fruit-grower, but here again appreciation and application of the principles involved in the use of honeybees as pollinating agents will in many cases lead to increased yields.

The factors which control the behaviour of the honeybee in the field are extremely complicated and often mutually interdependent, but the elaboration of such a bee-counter[2] as described by Dr. A. C. Fabergé will materially assist in the elucidation of these problems, to the benefit of both the beekeeper and the grower.

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[1] Full accounts of the papers read will be published as Proceedings of the Association in the *Annals of Applied Biology*.

[2] To be described in the *Journal of Scientific Instruments*.

A METHOD OF PHYSIOLOGICAL ASSAY OF PYRETHRUM EXTRACTS

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THE need for economy in the use of pyrethrum extracts in insecticidal practice makes necessary the continuous search for substitute toxic agents or at least for activator substances which may be added to pyrethrin mixtures as adjuvants to raise their effectiveness and thus cut down the consumption of pyrethrin. Parkin[1] published in NATURE the description of a method of biological assay of pyrethrin sprays in which the test insects (*Tribolium castaneum*), bred and kept under rigidly controlled conditions, are exposed by means of a standard method of application to various concentrations of pyrethrum extract in heavy oil. This method yields a reliable discrimination between the toxic effect of two solutions differing by 0·1 per cent in their content of pyrethrin I, which amounts roughly to a difference of 0·2 per cent in their total pyrethrin content. According to Parkin, careful organization of a steady supply of insects from controlled stocks is one of the factors essential for the practical success of this method of assay.

It is obvious that the amount of such insects available might easily become a bottleneck, whenever a greater number of substances in various combinations have to be tested for their toxicity. A method that would allow the carrying out of rapid preliminary tests and at the same time yield a fairly high degree of accurate indication of the relative effectiveness of pyrethrin preparations of various compositions and strengths, without necessitating the use of such valuable insect material, should therefore prove very useful.

During physiological investigations into the nature of the action of pyrethrin on the insect nervous system, a method was worked out which might serve this purpose. This method is based on the observation and recording of action potentials in the exposed abdominal nerve cord of *Blatta orientalis*, by means of a standard resistance capacity coupled amplifier in conjunction with an oscillograph and a loudspeaker. A detailed account of the method and the results of the physiological investigation will be published elsewhere. In the present article it may suffice to give the following outline of the experimental procedure. The abdomen of an adult female cockroach is severed from the thorax and pinned down ventral side upwards on a piece of cork. A median strip of the body wall is then cut out, deflected backwards, and pinned down as shown in Fig. 1. The ventral nerve cord is thus fully exposed for the insertion of the recording electrodes and for the application of the pyrethrum extract to be tested. The grid electrode is placed on the 5th abdominal ganglion, the neutral electrode rests on a pad of cotton wool soaked with saline which is in contact with the abdominal tissues. The electrodes are mounted in a metal screen box connected to earth, protecting the preparation from outside electrical interference during observation.

Of the various types of action potentials that can be recorded from such a preparation, one is of particular importance for the present purpose, since it is easily recognizable by the typical sound it produces in the loudspeaker, and because its disappearance under the influence of pyrethrin furnishes a clear end point, which can serve as a criterion for the speed of action of the toxic agent under observation. The potential in question arises in so-called giant-fibre neurons, situated in the 6th abdominal ganglion, which make synaptic connexion with afferent sensory fibres from the hair sensillæ on the cerci and which send giant fibre pathways forward into the central nervous system[2]. The potentials are of relatively high amplitude and arise whenever the hair sensillæ on the cerci are stimulated by a puff of air directed against the cerci. Fig. 2 shows an oscillographic record of the effect of such cercal stimulation. The high amplitude spikes represent the above described giant-fibre discharge. An unmistakable series of crackling reports can be heard in the loudspeaker whenever such giant-fibre potentials arise in the cord. The acoustical recognition is so easy that the use of oscillograph and camera can be dispensed with in actual practice. The cerci can easily be stimulated by gently blowing against them.

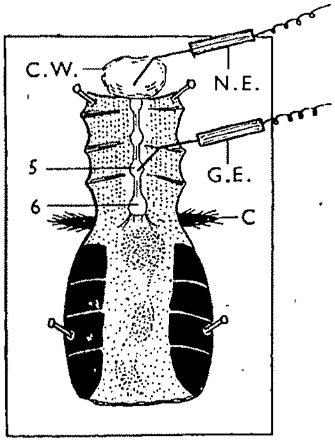

Fig. 1. Exposed ventral nerve cord of *Blatta orientalis*. *C.*, cercus; *C.W.*, pad of cotton wool; *G.E.*, grid electrode; *N.E.*, neutral electrode; 5 and 6, fifth and sixth abdominal ganglions.

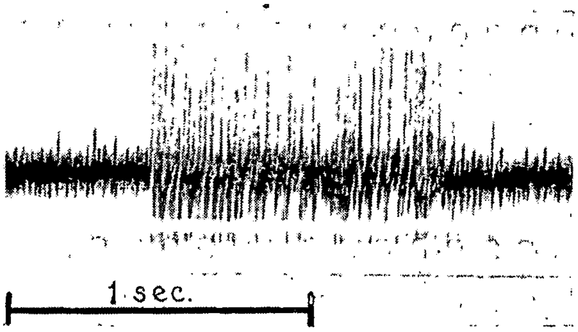

Fig. 2. Oscillograph record of giant-fibre response to stimulation of cercal hair-sensillæ.

Under the influence of pyrethrin a strict sequence of pathological events occurs. After an initial excitatory phase, marked by a massive discharge of a number of types of impulses, a spontaneous synchronized discharge of continuous trains of giant-fibre potentials becomes prominent. After this the response of giant-fibre neurons to sensory stimulation becomes abnormal in various ways and at last fails completely to occur. The disappearance of this response heralds the final decay of the electrical activity of the preparation. The time taken from the moment of application of the insecticide to the disappearance of the giant-fibre response shows a clear dependence on the concentration of the pyrethrum extract used.

This is borne out by the result of seventy experiments in which solutions of 0·07, 0·13, 0·23, 0·33, 0·65, 0·95, 1·3 per cent total pyrethrins in heavy oil were applied, ten experiments being carried out with each of these concentrations. At one minute intervals after application of the insecticide the preparation was stimulated via the cerci to test for the presence of the giant-fibre response. The experiments were continued until the giant-fibre response had finally disappeared. The time of observation was restricted to a maximum of one hour, in order to exclude any interference by pathological effects other than those caused by the insecticide.

The accompanying table shows the mean survival times of the giant-fibre response found for each group of ten experiments at 19–20° C. Plotted

% total pyrethrins	Mean survival time of giant-fibre response (min.) at 19–20° C.
0·07	>45·5*
0·13	26·8 ± 7·1
0·23	4·7 ± 1·0
0·33	2·3 ± 0·6
0·65	2·2 ± 0·8
0·95	1·7 ± 0·5
1·30	0·6 ± 0·2

* In five out of the ten experiments with this concentration the survival time of the giant-fibre response exceeded 60 min., the maximum time of observation.

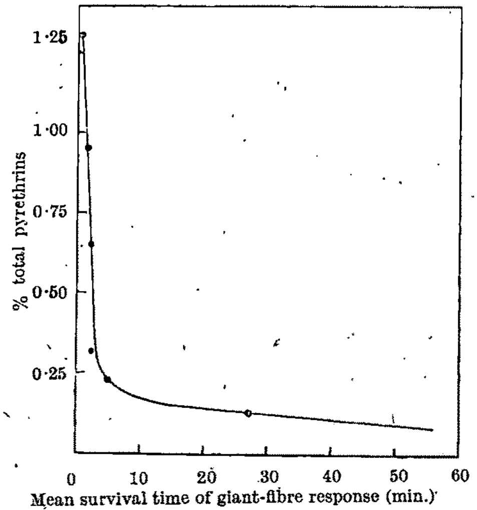

Fig. 3. TIME-CONCENTRATION CURVE (EXPLANATION IN TEXT).

against concentrations, these values yield a hyperbolic time-concentration curve shown in Fig. 3. As can be seen from the magnitude of the standard error of the mean values there is a considerable scatter of the individual readings within each group. This is only to be expected in view of the fact that the experimental animals were obtained by trapping in various localities, and differed not only in size and age but also in other respects, such as amount of fat body, hydration of tissues, etc. A further factor responsible for such variations in 'survival time' is the difficulty in the application of a standard amount of insecticide. The solutions were applied freely all over the exposed tissues of the preparation by means of a No. 1 water-colour brush, every care having been taken that no part of the ventral nerve cord was left protected by remnants of fat body. Differences in the amount of body fluid present, however, can have quite a decided effect on the speed of penetration of the oily pyrethrin solutions into the nervous tissues.

The discriminating power of this method is fairly poor for concentrations above 0·33 per cent total pyrethrins, a concentration which seems to represent an upper limit above which an increase in pyrethrin content does not proportionally hasten the drug's toxic effect on the exposed nervous system. The observed mean difference in survival time for 0·23 per cent and 0·13 per cent solutions is, however, of a completely satisfactory statistical significance. At this point of the range of concentrations the method is most sensitive, and the clear discrimination between the physiological effects of two solutions differing by only 0·1 per cent in their total pyrethrin content compares quite favourably with the maximum sensitivity to a difference of 0·2 per cent total pyrethrins yielded by the method of biological assay described by Parkin[1]. The fact that the physiological method of assay here described is most sensitive near the lower end of the scale of concentrations is a necessary consequence of the direct application of the insecticide to the exposed nervous tissues. For intact insects a comparable critical range of concentrations seems to lie in the neighbourhood of 1·6 per cent or 1·3 per cent total pyrethrin content. This factor has to be taken into account in comparing the results gained by the two different methods of assay. It is tentatively suggested that there is an approximate correspondence in toxic effect between a 1·6 per cent pyrethrin solution when applied externally, and a 0·3 per cent solution of the same composition on direct application to the exposed nervous system.

The advantages of the physiological method, which, apart from its usefulness in qualitative tests, appears to be especially suitable for the preliminary quantitative assay of relative toxicities, may be summed up as follows:

(1) The test animals (cockroaches) are easily obtainable and ten animals only are necessary for each test. More valuable insect material can thus be saved for a small number of final 'biological' tests.

(2) The exposure of the nervous system does not represent any technical difficulty; the preparation can be mounted for electrical observation within two to three minutes from the beginning of the dissection, and the ten experiments necessary for each test can be completed in a maximum time of 5–8 hours.

(3) The sensitivity of the method is unexpectedly satisfactory, considering the variability and relatively small number of test insects used.

(4) The fact that acoustical diagnosis is completely sufficient to furnish a satisfactory end point at low amplification renders the use of a costly oscillograph and recording camera unnecessary. The apparatus need therefore only consist of a standard 3–4-valve resistance capacity coupled amplifier in conjunction with a one-valve power stage and a loudspeaker.

(5) The experimental procedure as adapted for practical testing is sufficiently simple to be carried out in a routine way by any trained biologist. It does not call for specialized experience in electrophysiology.

[1] Parkin, E. A., NATURE, 149, 720 (1942).

[2] Pumphrey, R. J., and Rawdon-Smith, A. F., *Proc. Roy. Soc.*, B, 122, 106 (1937).

OBITUARIES

Mr. M. P. J. Swift, and Mr. M. J. Swift

THE name of Swift has been associated with the manufacture of scientific instruments since the inception of this firm in 1852, and has been a household word whenever microscopes have been mentioned. By the death of Mansell Powell John Swift on October 12, 1942, at the age of fifty-seven, the firm has lost one of its outstanding figures. M. P. J. Swift was educated at University College School, London, and entered the firm when he was eighteen. He did much towards raising the microscope to its present high standard of precision, especially by attention to detail both in its optical and mechanical requirements. His interest in the development of the polarization microscope was well known, and the various optical accessories connected with this branch of work (for example, Nicol, Glan-Thompson prisms, retardation wedges, etc.), always difficult to make, held a peculiar attraction for him. His energy, enthusiasm, and thoroughness in all he undertook was maintained to the end: a most likable man, who will be greatly missed by all who knew him.

By a strange coincidence, Mansell James Swift, father of M. P. J. Swift, died within one day of his son, namely, on October 13, at the age of eighty-eight. He was apprenticed to his father James Powell Swift (1826–1906), who founded the original firm, and who himself served as an apprentice with Messrs. Ross, Ltd. He was a fellow of the Royal Microscopical Society for thirty-six years.

The interest in scientific and optical instruments displayed by the three members of the firm mentioned above goes back yet one more generation. Thomas Swift (1799–1882), father of James Powell Swift, although at one time a hosier in Fenchurch Street, London, was sufficiently interested in scientific instruments to open such a business in Bendigo, Australia, where many microscopes were sent out to him by his son.

With such a background, the name of Swift will doubtless continue to be associated with optical instruments and microscopes of high quality.

B. K. JOHNSON.

NEWS and VIEWS

Prof. D. B. McQuistan

PROF. D. B. MCQUISTAN, who recently retired from the Freeland chair of natural philosophy in the Royal Technical College, Glasgow, has now, through failing health, been forced to relinquish a lifetime devoted to the cause of education. A brilliant student of the University of Glasgow, he was awarded the Thomas Logan Memorial Medal and Prize for the most distinguished graduate in arts of his year, with first-class honours in mathematics and natural philosophy, and in classics. The William Houldsworth research studentship afforded him the opportunity of spending a profitable year at the University of Cambridge, and, along with his later services as a mathematical teacher, he was well equipped for the duties of the chair which he afterwards occupied with great distinction. Many thousands of students will remember with gratitude his lucidity as a lecturer, and his exceptional aptitude in clarifying any difficult mathematical or scientific complexity. His popular lectures of scientific interest to varied audiences were an inspiration to the expert and a delight to the novice.

We regret to announce that it will no longer be possible, on account of the limited supply of copies of NATURE available, to give authors of "Letters to the Editors" more than one copy of an issue in which their contribution appears.

On his retiral, Prof. McQuistan was chairman of the Board of Studies at the Royal Technical College, and for many years he did invaluable and onerous work as convener of the Business Committee of the General Council of the University of Glasgow. His colleagues in the Dumbartonshire Education Authority will undoubtedly miss his unfailing and ungrudging service. His logical mind and calm temperament were always conducive to wise decisions. With unerring instinct he foresaw the possibilities of the film as an aid to education, and was convener of the Advisory Committee on the Production of Educational Films, under the auspices of the Scottish Film Council. Prof. McQuistan's present absence from active participation in educational matters creates a void, and his many acquaintances will cherish his great teaching qualities, his brilliant intellect, and, above all, his charming and lovable personality.

Ignaz von Born

ON December 26 occurs the bicentenary of the birth of Ignaz von Born, one of the first to realize the great part fossils were to play in historical geology and the first to describe the use of mercury in the extraction of gold and silver. Born at Carlsburg in Transylvania, he was educated at Hermannstadt and Vienna, and studied law at Prague. He then made a journey through Germany, Holland and France studying the minerals, mining, etc., and a year or two later made another mineralogical journey through Hungary and Transylvania. An account of this second journey, in the form of letters, was published in 1774 by the Swedish mineralogist, J. J. Ferber (1743–90). At Prague, where he held a post as mining councillor, Born assisted in forming a scientific society. In 1776 he was called to Vienna by the Empress Maria Theresa to arrange the natural history collections, which he afterwards described in a fine work. He continued to reside at Vienna until his death on July 24, 1791. One of the last of his books was his "New Process of Amalgamation of Gold and Silver Ores . . ."

Born's "Travels through the Banat of Termeswar, Transylvania and Hungary" and his book on "Amalgamation" were translated into English by a clever but unscrupulous German, Prof. Rudolf Erich Raspe (1737–94), who after stealing coins from the collections at Cassel fled to England, where he was already a foreign member of the Royal Society. After a period Raspe's name was struck off the rolls of the Society and he took to writing for a living, and while acting as storekeeper and assayer at Dolcoath Mine in Cornwall wrote the original part of "Baron Munchausen's Narrative". Later on, Raspe obtained money from the public-spirited Scottish baronet, Sir John Sinclair (1754–1835), by pretending to discover gold and silver on his estate at Ulbster, Caithness, an incident commemorated by Scott's character "Dousterswivel". Sinclair, it may be added, was one of the subscribers to Raspe's translation of Born's "Amalgamation".

Research on Coal Utilization

SIR EVAN WILLIAMS announced, in his presidential address to the British Coal Utilization Research Association on December 17, that a scheme utilizing £1,000,000 in five years for research on coal has been prepared. He said that this is by far the largest co-operative research scheme ever undertaken in Great Britain for the development of an industrial asset. The scheme has been approved by the Department of Scientific and Industrial Research, which has undertaken to contribute £50,000 a year to the cost, and £250,000 over the five years. The Mining Association will contribute £80,000 a year and £400,000 altogether, and the balance of £70,000 a year will be provided by associations of manufacturers who make plant and equipment for using coal.

Among the purposes of the scheme is the development of new processes based on coal which will create employment and strengthen export trade. Improvements in methods of using coal for light and power, for the production of materials for the chemical industry, the development of such substances as plastics, and the production of liquid fuels will be among the subjects of investigation. Sir Evan Williams said that the Ministry of Planning has asked the Coal Utilization Research Association to carry forward to the production stage economical domestic heating appliances which have been devised so that they may be procurable for the post-war house building programme.

Geographical and Geological Research in the U.S.S.R.

ONE of the first aims of the Russian Academy of Science founded by Peter I in 1724 was the geographical study of the country's natural resources and populations. Geography and geology have also been kept in the forefront of the manifold activities of the present Academy of Sciences. In 1920 a systematic scientific study of raw materials was undertaken with the view of co-ordinating the industrialization of the Soviet Union with the distribution of essential minerals. The work has borne fruit, for example, in the development of great apatite, copper and nickel industries in the arctic tundras, and of the sulphur industry in the sands of Karakum, and in the exploration of the vast oilfields known as the 'second Baku', lying between the River Kama and the Ural Mountains. These last explorations proved of inestimable value when the wholesale transfer of industry to the east was made necessary by the German invasion.

During the past twenty-five years the Academy has sent more than five hundred expeditions to every part of the Soviet Union to study geological and agricultural resources. In 1917 only 10 per cent of the country had been surveyed geologically; now the proportion is 50 per cent. Maps of soils and vegetation have also been prepared, as well as general maps for European Russia. Geological calculations show that the Union occupies first place among all countries of the world in respect of resources of iron, manganese, apatite, phosphorites, potash salts and niobium, and second place in respect of coal, zinc, lead and nickel.

The Ukrainian Academy of Sciences

AN account of the war-time activities of the Ukrainian Academy of Sciences has recently been received from the U.S.S.R. Early in the War the Academy was transferred to the interior of the country, where it resumed work. It was faced with complex problems which had to be tackled at short notice, in particular the readjustment of its entire scientific activities to meet the requirements of national defence and an expanding production programme. At the present time a large part of the Academy's work relates to aircraft and tank construction. Comprehensive studies are being made of the power resources of the Urals and Bashkiria, where new war industries have sprung up.

Biological institutes are investigating new methods of treating wounds and preventing infection. An anti-reticular cytotoxic serum has already been placed at the disposal of hospitals and has proved its value in accelerating healing processes. Close contact has been established between the Academy research workers and the war factories. A special technical committee has been set up to co-ordinate the Academy's research programme with the demands of the war effort. Another committee is studying the scientific problems of reconstruction that will require immediate solution when the Ukraine is liberated from the German yoke.

The Sky in North Africa

A SECOND edition of the "Star Atlas for the Latitude of Egypt", compiled by H. E. Hurst, M. R. Madwar and A. H. Samaha, and published by R. Schindler, Cairo, will be welcomed by members of the British forces campaigning in North Africa. It is designed for use in latitude 30° N., but can be employed without difficulty between 20° and 40° N.; it may therefore be of service in North India, South China, and the southern United States as well. It consists of six circular star charts covering the whole sky visible throughout the year in those latitudes, the centre of each chart being the zenith of the observer and the circumference his horizon. The successive charts represent the appearance of the sky throughout the twenty-four hours of a given day at four-hour intervals, or alternatively throughout the year at a given time of night at two-month intervals. A transparent graticule of the same size of the charts can be used to estimate altitudes and azimuths of the stars.

The text accompanying the charts illustrates their use and gives a clear description of the apparent movements of the stars, the planets, and the sun and moon, and even touches upon the modern conception of the structure of the galaxy. In solving many practical problems the atlas may prove invaluable; for example, in choosing a suitable guide star for marching on a given bearing, in reckoning the azimuth of a terrestrial object, and in estimating the time during the night. Such information must often have been in demand in the quick-moving campaigns of the past two years. When the charts are not employed in such immediately useful ways, the accompanying notes may awaken the scientific interest of those living in lonely camps with little to occupy their spare time. The atlas is handy in size and the charts are excellently drawn and reproduced.

Production of Synthetic Rubber in Sweden

THE scarcity of rubber is being felt more and more in Sweden. While through a rapid perfection and large-scale adoption of producer-gas the motor fuel problem has been relatively satisfactorily solved, it is now the shortage of rubber and lubricants that is the great cause for anxiety and which has made necessary the imposition of further restrictions on motor traffic. To try to improve the situation, experiments with the production of synthetic rubber have been going on for some time at various institutions. Promising results have been reported from the Physico-Chemical Institute at Uppsala, where experimental production has been carried on under the guidance of Prof. The Svedberg, as well as by the Swedish cellulose concern, Mo and Domsjö, which has evolved a product that is stated to be able to replace rubber for many purposes and which will be produced on a commercial scale in the near future. A young Swedish scientific worker, Dr. Gösta Ehrensvärd, of the Wenner-Gren Institute in Stockholm, has succeeded in developing a kind of artificial rubber which seems to possess several good qualities. Production on a small scale has been going on for some time at one of the rubber factories of the Swedish Co-operative Wholesale Society, which is supporting his researches and will probably exploit the new product. It belongs to the so-called 'thioplast' products, the weak point of which has hitherto been that they could not be vulcanized at a high temperature. This can, however, be done with the Ehrensvärd rubber. The unpleasant odour that formerly characterized such products has also been eliminated. Nothing has so far been said about the composition of the new product or of what raw materials it is being made, except that it is based on domestic raw materials and that the Swedish forests, in this as in so many other cases, will play an important part.

Photographic Analysis of Motion

A LECTURE on the "Photographic Analysis of Motion" was delivered at the Royal Institution on December 11 by Mr. E. R. Davies, director of research, Messrs. Kodak, Ltd. He said that the value of photography in the analysis of movements too rapid for the eye to follow was demonstrated, and the method successfully applied, in the classical investigations of Muybridge and Marey before the introduction of the dry plate in 1871. The great convenience of the new process compared with the laborious wet-plate technique, and its enhanced sensitivity, brought about many triumphs towards the end of the nineteenth century. The movements of animals and the flight of birds were analysed; projectiles travelling at speeds in excess of that of sound photographed; and the propagation of flames in gaseous combustion was followed. Modern progress had depended to a large extent upon the introduction of the cold cathode discharge tube in place of the far less luminous electric spark; on advances in the design of cinematographic and other types of camera; on the introduction of photographic materials of greatly increased sensitivity; and on the application of the photo-electric cell and the microphone to the problem of synchronizing the action with the camera exposure. Instantaneous photographs can now be taken with exposures of less than a millionth of a second and cinematograph pictures with a frequency in excess of 4,000 a second. A valuable tool has become available to science and industry, and has proved its worth in many fields. Its use in the design and testing of high-speed machinery is of particular importance at the present time.

Cancer-producing Mineral Oils

ADDRESSING a recent meeting of the Manchester University Branch of the Association of Scientific Workers, Mr. R. Lyth described how methods of preventing certain types of occupational cancer have been discovered. External cancers which are prevalent among Scottish shale oil workers have also increased among cotton spinners, since the introduction of mineral lubricating oils. In the Cancer Research Department of the University of Manchester, cancers have been produced in mice by repeatedly painting their skins with mineral oils. Shale oil was found to be much the most active carcinogenically, while Russian oil was one of the least active oils. The refractivity $(\mu - 1)/D$, where μ is the refractive index and D the density, could be roughly correlated with the carcinogenic properties, and used as an index of them. In the laboratory, various methods of reducing the activity of oils were found, but the cotton industry has found it more practicable to avoid the use of the more dangerous oils such as shale oil. For the shale oil workers themselves, the regular use of certain ointments has proved beneficial. Efforts to isolate the carcinogenic constituents of mineral oils have not yet fully succeeded. The meeting learnt with regret that the Cancer Research Department of the University of Manchester is being closed.

Frequency Stability of Radio Circuits

AT a meeting of the Students Section of the Institution of Electrical Engineers held on November 16, Mr. C. W. Eggleton read a paper on "The Frequency Stability of Tuned Circuits". The author dealt with the conditions with which it is necessary to comply in the design of commercial radio receivers in order to secure a satisfactory degree of frequency stability in the various tuned circuits of the receiver. The majority of broadcasting receivers in use at the present time are of the supersonic heterodyne type using a local oscillator, and it is the frequency stability of this oscillator which usually determines the stability of the whole receiver, particularly when the required reception is within the short-wave band. Variations of the frequency of any tuned circuit are occasioned chiefly by the effect of temperature, and to a lesser extent by condensed moisture, on the electrical characteristics of inductance coils and condensers. In the paper, the author directed attention to the desirable properties of the materials used in the construction of these components, and to the importance of various features of design. An important point in connexion with the layout of the whole receiver is to ensure that the local oscillator and the main radio frequency circuits are kept as far away as possible from the power frequency components, which largely form the main source of heat generated in the receiver.

London Gulls

IT is reputed (*Countryside*, 12, No. 5, 93; 1942) that it is exactly fifty years since flocks of gulls began to winter on the London Thames, in the severe winter of 1892. Most of these birds are black-headed gulls, but whether or not the severe winter of 1892 was the origin of gulls frequenting the Thames embankment in numbers is not accepted by all ornithologists. T. L. Bartlett notes that sixty years ago the occasional appearance of gulls in London caused unusual interest amongst ornithologists, and although there were occasional records of gulls passing up-river in severe weather, the first winter occupation of central London by black-headed gulls appears to be the severe winter of 1892 at Blackfriars Bridge, where new legislation protected them from gunshot. But the black-headed gull has not really changed its habit: it was always known as an inland as well as coastal bird. The difference in the past fifty years has been its great increase in numbers—which may be from biological reasons—and its protection under the bird laws which give it encouragement to stay on waters where formerly it was persecuted and driven away. Bartlett, however, suggests also that they were encouraged to winter on the Thames after 1892 by the public feeding the gulls with large sprats, and fifty years of embankment feeding with bread have changed its ways to a town gull. The habits of Thames gulls have, however, been given exaggerated importance. Similar changes in the status of the black-headed gull have occurred in the Mersey and other rivers where there was no great public feeding of the gulls, and the flocks became regular winter inhabitants of the park lakes.

Regional Survey Atlas of the Croydon District

THE ambitious project for a regional survey atlas covering some 200 square miles around the Borough of Croydon was begun by the Croydon Natural History and Scientific Society so long ago as 1913. Despite the difficulties of war-time conditions, it has been continued by the issue this year of a third series of maps and printed matter (*Proc. Croydon and Dist. Nat. Hist. and Sci. Soc.*). In contrast to similar local surveys which have been attempted in other parts of Great Britain, the Croydon scheme is based essentially on the idea that a regional survey is never of necessity complete, and hence the actual work is to be contained in a loose-leaf binder which was issued with the first series of maps; the contents as originally planned can therefore be added to as experience and the progress of knowledge may dictate.

The two previous issues of maps have included base maps, maps dealing with rainfall, relief, drainage and a number of historical maps as well as some referring to population and planning. The present, or third, issue contains only one map—of bronze age remains—but has the textual statement by Mr. Fagg on geological structure and history, illustrated by geological sections, and an account of the natural vegetation, together with a list of plants normally found on the chalk of the region, a section contributed by Mr. C. T. Prime. The description of the bronze age map is by Mr. A. W. G. Lowther. It is to be hoped that there will be sufficient public support for the venture to enable it to be continued and to afford the necessary encouragement to Mr. C. C. Fagg, who has been the organizer.

Indian Forest College, Dehra Dun

THE Progress Report of the Indian Forest College, Dehra Dun, 1940–41 (Manager, Government of India Press, New Delhi, 1941), states that the College was opened in May 1938, after a period of closure, for the training of candidates for the Superior Forest Services of the various Provinces and States of India. The course extends over two years, each class completing its course before a fresh class is admitted, so that there are no overlapping classes. This first course lasted from May 1938 until March 1940. The report in question covers the first year's work of the second course, which was to end in March 1942. At the prize-giving at the end of the first two-year course the President and Principal of the College both spoke in laudatory terms of the work achieved and the type of man and training which the College is turning out.

The movement will be watched anxiously by old Indian forest officers, who have seen the growth of, and the fine results attained by, the Indian Forest Service. They ask how will the standard be maintained by a series of devolutionized, entirely independent forest departments in the provinces, staffed in the higher grades in the future by men trained in a college the staff of which has had no opportunities of rubbing shoulders with confrères in their own subjects. Moreover, men trained in this fashion will not have had the advantage of training in one of the old universities, where they mix with men who are getting other courses of education; and finally they will not have the opportunity of combining this training with visits to European continental forests which is so desirable.

The Night Sky in January

NEW moon occurs on January 6d. 12h. 37m. and full moon on January 21d. 10h. 48m. The following conjunctions take place during the month: Jan. 4d. 10h., Mars in conjunction with the moon, Mars 5° S.; Jan. 7d. 22h., Mercury in conjunction with the moon, Mercury 3° S.; Jan. 16d. 10h., Mercury in conjunction with Venus, Mercury 2·7° N.; Jan. 16d. 19h., Saturn in conjunction with the moon, Saturn 3° N.; Jan. 20d. 12h., Jupiter in conjunction with the moon, Jupiter 3° N. Occultations of stars brighter than magnitude 6 are as follows, the times referring to Greenwich:

	d.	h.	m.			
Jan.	14	19	43·2	μ	Ceti	D
	15	17	37·7	f	Tauri	D
	16	17	31·0	γ	Tauri	D
	16	23	25·6	θ′	Tauri	D
	16	23	46·6	75	Tauri	D
	17	00	32·9	264B.	Tauri	D
	25	00	29·3	χ	Leonis	R

Mercury attains its greatest elongation, 19° E., on Jan. 8. Venus sets about an hour after the sun in the middle of the month and is not very favourably placed for observation in Great Britain. Jupiter and Saturn continue to be well placed for observation, the former southing about midnight and the latter at 20h. 40m. in the middle of the month. The earth makes its closest approach to the sun on January 2.

Announcements

SIR JOHN C. G. LEDINGHAM is to retire on March 31 from the post of director of the Lister Institute of Preventive Medicine, which he has held since 1930. To succeed Sir John Ledingham in the directorship, the Governing Body of the Institute has appointed Dr. A. N. Drury, Huddersfield lecturer in special pathology, University of Cambridge, and member of the scientific staff of the Medical Research Council.

AT the annual general meeting of the British Mycological Society on December 12, Dr. S. P. Wiltshire, director of the Imperial Mycological Institute, Kew, Surrey, was elected president for 1943.

THE Board of Trinity College, Dublin, has invited Prof. J. M. O'Connor, professor of physiology in University College, Dublin, to deliver the John Mallet Purser Lecture in 1943.

THE Central Council for Health Education is making plans for its 1943 Summer School. The School will probably be held at the Chelsea Polytechnic during August 4–14, and will deal with the teaching of biology and with health education generally. While teachers of biology will find the full ten days of value, educational administrators and youth leaders will find the first three days of the School of special interest to them. Further details may be obtained from the Education Officer, Central Council for Health Education, Tavistock House, Tavistock Square, W.C.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Experimental Evidence of the Existence of Element 85 in the Thorium Family

BESIDES the branching of the C products in the three radioactive families, Mlle. Perey and Lecoin[1,2] have shown another branching in actinium, leading to the creation of element 87. Turner[3], considering the regularities in the distribution of isotopes, has concluded that actinium A, thorium A and radium A should also be β-active. Thus, the element 85 would be created. We have therefore tried to separate element 85 from some 40 mgm. of radiothorium which we had at our disposal.

As 85 is a halogen, it should sublime easily like its homologue iodine, so it seemed simplest to separate it by sublimation in the following way. In order to obtain the disintegration products of thorium A, particularly 85, in sufficient quantities in a short time, the thorium emanation ($T = 54$ sec.) was blown for about 20 min. between two copper sheets 2 cm. × 1 cm., one negatively and the other positively charged, thus obtaining the radioactive deposit on the negative electrode, from which the 85 was sublimed at the temperature of a hot oil bath (about 180° C.) on to a constantly cooled silver wire. After 10 min. of sublimation this wire was removed and placed in a Wilson expansion chamber. (The arrangement for the accumulation of the radioactive deposit was such as to eliminate any possibility of contamination with radiothorium or thorium X. The Wilson expansion chamber was in a different wing of the Institute, and thus any other accidental contamination was also excluded.)

The following observations were made:

For the first 10–20 min., varying in different extractions, no tracks were observed in the expansion chamber. Then α- and β-tracks began to appear, very slowly, from different parts of the gas, or from the walls of the expansion chamber, but practically never starting from the silver wire. The α-tracks were always observed in pairs. During the expansions a halo of mist surrounded the silver wire for the first 30–40 min. from the time it was placed in the expansion chamber, and afterwards disappeared. The pairs of α-tracks continued to be present in the expansion chamber for about two days.

Both tracks of the pairs seemed to start from the same point. Stereoscopic photographs, however, showed that their starting points were not identical, but were separated by a maximum distance of 5 mm.

Whenever the disintegration took place at the best illuminated level of the expansion chamber, the pair of α-tracks was seen to be accompanied by a β-ray with the same starting point as one of the α-tracks. This β-ray was so often observed that it is more probably a primary ray than a secondary ray produced by an internal conversion of a γ-ray.

Many photographs were made of the double tracks; and on some the β-track also seemed faintly visible, the lighting system being too weak and the light power of the objectives of the photographic camera being only 1 : 4 : 5. Without an automatic chamber connected with a photographic camera, there was almost no chance of photographing the tracks in the gas in the middle of the expansion chamber so that the whole length of both α-tracks could be measured; and as, owing to the War, films were difficult to obtain, they could not be wasted in the faint hope of obtaining such a disintegration. Nevertheless, the double and even the triple tracks were observed so frequently that their existence could be taken as established.

From the above observations one could conclude that we had succeeded in separating and in placing in the expansion chamber a hitherto unknown element and its disintegration products. The method used for separating this element suggests that it is 85.

Although the disintegration thoron $\xrightarrow{\alpha}$ thorium A $\xrightarrow{\alpha}$ thorium B would produce pairs of α-tracks with the same starting points, the observed tracks could not be due to this contamination for the following reasons:

(1) If the expansion chamber had been contaminated with the thorium emanation, as its period is only 54 sec., the initial amounts would have to have been enormous to continue to produce pairs of α-tracks after two days, as were found in our experiments.

(2) A contamination with thorium X, of which the disintegration products would again be thoron → thorium A → thorium B, is disproved by the fact that practically no tracks were observed starting from the silver wire, by which alone thorium X could have been brought into the expansion chamber, and from which its α-tracks would have been observed to start.

(3) From all the photographs taken, only one α-track of the pairs (the one connected with the β-ray) could be measured exactly from its beginning to its end, its length being 5·2 cm. (15° C., 760 mm.). In another photograph the incomplete length of one of the tracks of the pair was about 7 cm. These lengths also show that the pairs in our experiments are not due to the thoron → thorium A → thorium B disintegration, since the lengths of these α-tracks are much shorter.

A possible explanation for the tracks appearing in the gas and from different parts of the expansion chamber, instead of from the source (the silver wire), could be given by the suggestion that 85 filtered away from the source in a very short time after being

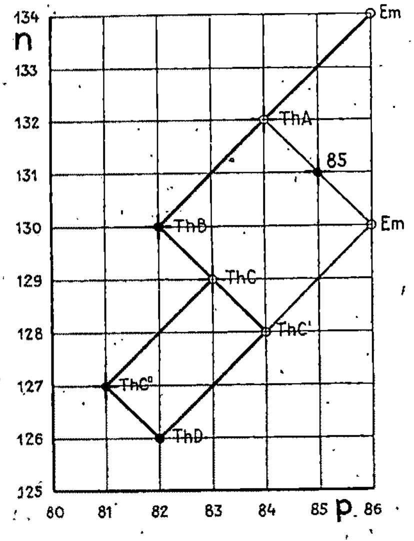

Fig. 1.

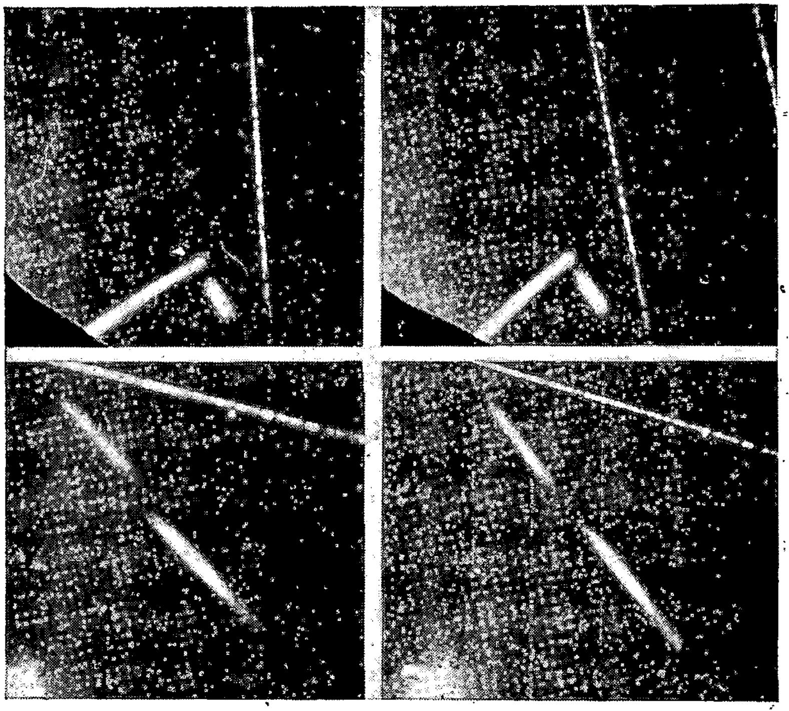

Fig. 2.

placed in the expansion chamber, due to (1) its high vapour pressure and (2) its predicted faculty of easily creating highly volatile compounds. The silver wire was cooled during the sublimation and until it was placed in the expansion chamber. During that time a coat of moisture deposited itself on it. The halo of mist which was observed during the first 30–40 min. may have caused the apparent retardation of the tracks, as, so long as it was present, the tracks starting from the silver wire may not have been visible and the 85 could have filtered away during that time.

The accompanying diagram (Fig. 1) attempts to give an explanation of the disintegrations observed in our experiments.

After the normal disintegration of the thorium emanation by α-radiations into thorium A, the branching takes place. The main part of thorium A disintegrates by α-radiations into thorium B and its after-products. An extremely small portion would disintegrate by β-radiations into the element 85, which would continue to disintegrate by further β-radiations (probably with a fairly long period) into a new isotope of the thorium emanation $^{216}_{86}\mathrm{Th}\,n$, for which the neutron proton relation $n/p = 1{\cdot}512$, therefore suggesting a much bigger probability for an α-disintegration, which manifests itself by a much shorter period than that of the known thorium emanation, for which $n/p = 1{\cdot}558$. The emanation $^{216}_{86}\mathrm{Th}\,n$ would, then, through an α-disintegration, produce an isomeric thorium C′ atom, which would disintegrate by an α-transition into inactive thorium D.

Thus, the triplets which were observed to start in the gas could be accounted for as follows: the β-ray belonging to the atom 85; one of the α-rays belonging to the atom of the new isotope of the emanation $^{216}_{86}\mathrm{Th}\,n$; the other α-ray belonging to an isomeric thorium C′ atom.

The two stereoscopic photographs (Fig. 2) of the pairs of the α-tracks starting in the gas which are reproduced herewith show the difficulty of measuring their length.

As a tribute to the scientific work of our two countries, we propose to name the element 85 'anglo-helvetium'.

Our thanks are due to Prof. Adolf Liechti, director of the Röntgen Institute in the University of Berne, who facilitated and encouraged the above work, which was carried out in his institute; to Prof. P. Scherrer, of the Eidgenössische Technische Hochschule of Zürich for the loan of the Wilson expansion chamber; and to Mr. Albert Benteli of Berne for his trouble in supplying and preparing the radio-thorium, which was provided by Dr. A. Wander of Berne for cancer research in the Röntgen Institute in the University of Berne.

Alice Leigh-Smith.
Röntgen Institute,
Walter Minder.
Radium Institute,
Berne. Nov. 1.

[1] Perey, *J. Phys. Rad.*, **10**, 435 (1939).
[2] Perey and Lecoin, *J. Phys. Rad.*, **10**, 439 (1939).
[3] Turner, Louis A., *Phys. Rev.*, **57**, 950 (1940).

Influence of Potassium on Sugar Metabolism

In a recent communication[1] Leibowitz and Kupermintz have demonstrated that in cultures of *E. coli* in *M*/60 glucose containing potassium chloride in a concentration of *M*/250 the potassium stimulates the utilization of the sugar in a similar manner to that noted by Pulver and Verzar[2], in the case of yeast. Immediately before the commencement of fermentation the potassium enters the yeast cell, reappearing in the external medium during fermentation proper. This initial entry may be connected with intracellular glycogen formation. The Donnan equilibrium would suggest that during rapid carbohydrate oxidation potassium should leave the cell, and enter when carbohydrate is being elaborated[3]. The possibility that the cell membrane may exert some effect on carbohydrate metabolism is suggested by observations on blood stored for transfusion purposes[4].

In order to investigate the influence of the cell membrane, we compared the stimulation by potassium (in concentration of about 0·005 per cent KCl) of the degradation of glucose in dilute solution (0·5–0·6 per cent) by yeast cells and by cell-free yeast extract. The effects of uranium instead of potassium and together with potassium were also examined in the cases of cells and cell-free extract, owing to the report by Zwaademaker[5] and others that in some physiological processes equi-radioactive quantities of potassium and uranium are interchangeable but antagonistic when employed together.

It was found that (i) potassium stimulates glucose

o a similar extent when cells and cell-
ıre used; (ii) that in both cases phos-
ates the glucose metabolism to about
gree as potassium, which is interesting
f the statement by Rapoport and Guest[6]
the minimum lethal doses of potassium
te ions are of the same order; (iii) that
ion is most marked when fermentation
ed only to a slight extent; (iv) that
er's relationship for potassium and
s not appear to hold for the degradation
y yeast or yeast extract.
indebted to the Director of Scientific
linistry of Supply, for kind permission to
communication. It is expected that a
port will be rendered in due course.

S. N. FARMER.
D. A. JONES.

ose Crescent,
S.E.2. Nov. 13.

, 233 (1942).
, 823 (1940).
Boyle, NATURE, 144, 710 (1939).
cet, 722 (June 7, 1941).
ysiol., 45, 147 (1917).
xp. Biol. Med., 49, 147 (1942).

otato Disinfection by Conveyor Belt Dipper

recently one of the factors limiting large-
lication of disinfection of potato seed for
ention of various diseases was that no suit-
liance had been evolved for handling large
seed potatoes. During 1940 and 1941 con-
tonnages of early varieties were dipped in
on lifting by a simple derrick erected over
ank of the solution. Although effective, this
entailed considerable labour and left much
esired.

der to provide for the disinfection of large
ies of seed potatoes expeditiously and with
m labour and damage, a plant has now been
, at our suggestion, utilizing the conveyor belt
e. The essential feature is a dipping tank
approximately 600 gallons, provided with a
or belt operating below the surface of the
n. This dipping plant can be worked in con-
n with the usual type of grader, the potatoes
lelivered from the picking belt of the grader
wooden chute into the solution, where they
horizontally for approximately one minute
e then elevated out of the tank at an angle of
he elevator delivers them directly into boxes
are immediately removed to the open field
acked there for drying, which takes only a few
es.

ing the present lifting season, more than 1,000
f Ninetyfold and Arran Pilot seed potatoes have
reated by a pair of these plants, installed by
Tractors, Ltd., Coupar Angus, for Mr. T. A.
erspoon of Eassie. The disinfectant used was
f the well-known organo mercury potato dis-
ants.

a result of the large-scale experience gained this
it is expected that the value of this principle
proved potato dipping will become established.

C. T. N. WAKELY.
H. C. MELLOR.

ayer Products, Ltd.,
Africa House,
London, W.C.2.

Civil Defence Against War Gases

THE article on "Civil Defence Against War Gases"[1] is substantially correct, but contains one serious and one minor error. It states that after the War of 1914–18 "the nations solemnly renounced the use of gas at a Geneva conference, a pledge which has so far been kept—nor is there any reason why it should be broken". The Italians quite certainly used gas against the Abyssinians. There is evidence[2] that the Germans have killed many thousand Jewish civilians with poison gas.

There is thus no moral objection to using poison gas against Italy, and, if the above reports are confirmed, none to using it against Germany. For poison gases are no more inhuman than other weapons used by both sides. I should prefer dying from lung œdema due to phosgene than from a septic wound or severe burns. There may be tactical objections at present, but if at a later stage in the War these cease to hold, I trust that the United Nations will not hesitate to use poison gas if experts think this will save the life of a single Allied soldier, sailor, or airman.

The other doubtful statement is that "everyone in Great Britain has a gas mask and knows how to use and care for it". They ought to know, but very many do not. The present lull in raiding might well be used to see that more of them do.

Finally, the opinion expressed as to the limited effects of a gas attack, though valid against the wild statements which were commonly made before the War, may require some modification in view of the new technique of concentrated raids. If gas bombs were dropped as widely dispersed in space and time as high-explosive bombs were in the London raids of autumn 1940, they could nowhere produce a lethal concentration of non-persistent gas except in the immediate neighbourhood of individual bombs. But if some hundreds of tons were dropped within an hour in a restricted area, they might generate a gas cloud of a dangerous density.

For this reason I think that the danger of a gas attack on some large British city is rather greater than readers of the article might believe, and the need for preparation more urgent.

J. B. S. HALDANE.

University College,
London.

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[1] NATURE, 150, 642 (1942).
[2] For example, *Polish Fortnightly Review*, 57, 2 (1942).

A Varnish for Fixing Smoked Tracings

IN damp weather it has been noticed that a good many varnishes produce a white precipitate when used for fixing smoked tracings after experimental physiology work. This naturally interferes with the final tracing and sometimes forms all over it, thereby obliterating the original work. We have prepared a great number of varnishes, and of them the following has been satisfactory. A white haze does form even with this varnish in a moist atmosphere, but it disappears on drying. The following is the formula for the varnish: gum juniper, 60 gm.; colophony resin, 13 gm.; castor oil, 5 mil.; industrial methylated spirits, 200 mil. This produces a glossy finish, ideal for demonstration purposes and even class work.

G. B. WEST.

College of the Pharmaceutical Society,
at University College,
Cardiff.

ELECTRIC STRENGTH OF VARNISH FILMS

IN a paper entitled "Intrinsic Electric Strength and Conductivity of Varnish Films and their Variation with Temperature" (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 23; November 1942), A. Morris Thomas and Miss M. V. Griffith discuss recent advances in the theory of the intrinsic electric strength of solids, and describe methods for the preparation and testing of samples of baking insulating varnishes and shellac-varnish films for the determination of their intrinsic electric strength. The varnishes tested were a clear baking oil insulating varnish, a black baking bituminous insulating varnish, a synthetic-resin insulating bakelite varnish, and a pure de-waxed lemon shellac varnish.

The results of the tests made on a thickness range of 0·02–0·1 mm., and a temperature range down to −196° C., are reported. The investigation also includes conductivity measurements, effect of different ambient conditions (immersion media and applied pressure), time/voltage tests, and the effect of centrifuging and filtering and comparison tests on varnish-impregnated paper films, which were made to establish the validity of the method of test and to assist interpretation of the results.

The large and continuous increase of intrinsic electric strength with decrease of temperature down to −196° C. which is found disposes of the assumption hitherto made by some investigators that this quantity is independent of temperature. Consideration of the results in relation to the recent theory proposed by Frohlich to account for a temperature-dependence of the character obtained indicates that this theory in its present form is not applicable, but an alternative explanation is suggested.

As the results of the research, the investigators reach the following conclusions. The intrinsic electric strength of varnish films is probably independent of thickness from 0·02 mm. to about 0·1 mm. at all temperatures, except that clear varnish films show a small decrease with the thicker samples at 90° C., and at low temperatures 0·04 mm. was the maximum thickness tested. The values for all four types of varnish investigated at −196° C. lie between 8,000 and 9,000 kv./cm. and decrease approximately linearly with increase of temperature up to 0° C., the exception being clear varnish. Above about 0° C. the decrease continues at a slower rate up to 60° C., and the values then tend to increase slightly up to 90° C., except that shellac gives a sharp fall. As the rates of decrease with increase of temperature differ, the values diverge, so that at 60° C. the maximum values are approximately 4,900, 3,300, 2,600 and 2,200 kv./cm. for the bakelite, shellac, black and clear varnish films respectively. The intrinsic electric strength of the bakelite varnish films is independent of time of application of voltage within the experimental range, but the other varnishes show decreases in maintained-voltage tests, which, however, may be a consequence of local defects due to inclusions or lack of film uniformity.

Relatively large inclusions of a dielectric such as cellulose in the form of paper are found not to affect appreciably the intrinsic electric strength of varnish films. The variation of the conductivity of varnish films with temperature is apparently of a complex nature and is not of a type which enables definite conclusions to be drawn with regard to the mechanism,
although the results are qualitatively
if it be supposed that ionic conduction
and electronic conduction at low, tem
results may be considered in relation
of the breakdown of organic solids rece
by Frohlich. If electronic conduction on
then the intrinsic electric strength of a
consisting of long-chain crystals should
increase of temperature, but the introdu
groups into the molecules may outwei
and cause a decrease. For this type o
occur, it is necessary that the tempera
ciently high to enable certain of the mol
to rotate, and such an effect may be r
an increase of dielectric constant.

The investigations of phenolformalde
films by Hartshorn, Megson and Rushto
an increase of dielectric constant due to
tion in substances of this type does not o
temperature of 20° C. is attained; th
constant then rises from about 3 to a val
80° C. This region corresponds to that
the intrinsic electric strength of the va
remains approximately constant, so that
in its present form is inadequate to e
results. There remains a possibility that
of the course of the temperature variat
occurs roughly at normal temperature
related to the change in the conduction
at about the same temperature. Referenc
to the agreement of the results with those
on amorphous glass. It is suggested t
materials of the type which have a colloidal
a falling intrinsic electric strength/te
characteristic may be explained by the rel
of electronic or ionic movement along
surfaces.

The paper is based upon report Ref. *L/T*1
British Electrical and Allied Industries
Association.

INTUITIVE KNOWLEDGE

IN a paper on intuitive knowledge in the
Mind of October, 1942, Prof. R. I. Aaron
the present position of the time-honoured
that there are certain propositions which th
mind can know without any shadow of
possibility of error. This doctrine, a legacy i
pean thought of the philosopher-scientist D
who took the deductive reasoning in geometr
pattern of scientific thinking and the self-
axioms of Euclidean geometry as the four
thereof, has come to seem less compelling n
those axioms are no longer regarded as self
by any educated person.

The author agrees, however, that to concl
this that the whole notion of intuitive k
must be discarded would be precipitate. T
do so, assert that any so-called piece of in
knowledge is either merely a statement a
certain linguistic forms are used (for exa
I know that 'no fishes have hair' necessit
'no creatures with hair are fishes', I am
knowing anything except the rule by w
English sentence can be transformed into a
or, if such knowledge goes beyond words to
world, it can never be absolutely certain (for
ample, when I know that my hand is before

m ing my pen across the page, there is some possi- fre , however small, of error). This latter con- ph n is based on the assumption that, as all state- th about the empirical are based on evidence, in e may at any given point be more evidence t ncoming which would shake the certainty of the a ment.

defence of intuitive knowledge the author main- ins that there are propositions which depend on dence but yet are absolutely certain because there uch a thing as conclusive evidence. For example, o know my hand is now moving my pen across page. This is an example of undoubted know- R e. This has been said before, of course, but it m worth while saying again in face of modern det ncies to dissolve away knowledge into mere ng about a universe hidden behind the veil of tion.

PERICARDIUM AND ERICARDIAL GLAND IN THE LAMELLIBRANCHIA

most recent number of the *Proceedings of Malacological Society of London* (25, Pt. 2) ly occupied by an important paper by Dr. n M. White on "The Pericardial Cavity and ial Gland of the Lamellibranchia". Present re workers on the morphology of the Lamel- s will be grateful for this paper which, without sary verbosity, summarizes existing know- n the subject and adds materially to it. A nge of material was examined, some eighty from seventy-one genera and forty-six . Excellent figures are given of conditions in species.

pericardial gland arises as paired groups of the anterior part of the pericardium. It may over the auricles only or over the dorsal and surfaces of the pericardium and into neigh- g parts of the mantle. In both cases it is and both pairs of glands may be present. unction is certainly excretory but the exact n of this to that of the kidneys remains some- bscure. In only one family (Donacidæ) and lated genera was the gland absent. The case a is interesting. Here the gland was found three out of seven species. Miss White es this with the presence of a pre-oral gland, ng Stenta who described this strange organ. sent in those species in which the pericardial is best developed. There is matter for further gation here. The pre-oral gland opens into ra-branchial chamber and is therefore unlikely oncerned with the extrusion of fluid excrement, would have to pass through the gills. On the hand, it could produce solid excrement because ould be ejected with other waste particles by the *inhalant* opening.

ariable relations between the heart and the m are mentioned. Typically, the rectum tra- e heart, but in a few species it passes above the heart. Miss White discusses possible al relations between the two organs, but em improbable and it is more likely that the t relations arise from purely morphological The interesting discovery was made that the may extend into the mantle in species of Arca, pondylus and Chama, a condition hitherto recorded ly in the Mytilidæ and Anomiidæ.

INSULATOR GLAZES

AN article by E. Rosenthal in the *Electrical Review* of November 27 discusses the influence of insulator glazes on porcelain, having particular reference to high-voltage insulators. Under a strong microscope the surfaces of unglazed ceramic materials show minute projecting peaks which make it evident that the quality of the surface has a great bearing on the surface resistivity. This, in turn, is largely dependent on the humidity skin which, in a moist atmosphere, forms on any surface to a thickness that increases with the surface roughness and with atmospheric humidity. With 30 per cent humidity, the surface resistance of unglazed porcelain ranges between 20 and 40 $\times 10^{12}$ ohms / sq. cm., but with 98 per cent humidity it is only about $0{\cdot}001 \times 10^{12}$. This decrease in surface resistivity is smaller the smoother the surface. In a dry atmosphere glazed porcelain has approximately the same surface resistance as unglazed porcelain, but in a humid atmosphere of, for example, 98 per cent humidity the figure becomes $0{\cdot}1 \times 10^{12}$ ohms/sq. cm. This dependence of surface resistivity on the quality of the surface and on the humidity content of the atmosphere is a characteristic not only of porcelain but also of all insulating materials.

The glaze on a porcelain insulator is composed of raw materials similar to those used for the body, but fluxes are added which cause the mixture to melt at the firing temperature of the insulator (1,300–1,400° C.). High-temperature insulator glazes (fired at a temperature of 1,300° C. and higher) have not only a very great influence on the surface resistivity of the insulator but also on its mechanical and physical characteristics. One of the most important factors which influence the mechanical characteristics of the glazed body is the ratio of the heat expansion of the glaze to that of the body. The most suitable glaze must be found by numerous experiments (by trial and error) for each and every body. The tensile strength, the modulus of rupture and other mechanical characteristics may be improved very considerably by the application of a glaze, the thermal coefficient of which bears the proper ratio to the thermal coefficient of the body.

The resistance to sudden temperature changes, however, may be more favourably influenced by another glaze. If the thermal expansion of the glaze does not agree with that of the body, a considerable decrease in mechanical strength may result.

Many experiments on tensile strength have been carried out in different countries and the results have been published by various authorities. In the United States it is reported that in special cases the tensile strength is increased by as much as 80 per cent by a suitable glaze, and an increase of 40 per cent is quite normal. Similar results have been obtained by Continental research workers, the tensile strength of unglazed porcelain being given as 240–320 kgm./sq. cm. and of glazed porcelain as 300–500 kgm./sq. cm. Tests carried out in English factory laboratories give similar results. The application of a suitable glaze not only increases the tensile strength but also the other mechanical characteristics. For example, the minimum compressive strengths of unglazed cylindrical test specimens possessing cross-sections of 160, 80 and 20 sq. cm. are 900, 1,000 and 1,700 kgm./sq. cm. respectively. Corresponding figures for glazed cylinders are 2,000, 2,300 and 4,300 kgm./sq. cm. These considerations apply only to porcelain glazes which fuse at the vitrification temperature of the porcelain as generally used in high-voltage insulator manufacture.

Glazes which are applied to the finished ceramic article and which are fused in a second firing at a lower temperature behave differently and are not able to increase the mechanical stress of the ceramic article. In contradistinction to high-voltage insulator glazes, this type of glaze must contain strong fluxes like lead oxide, etc., which are not present in the porcelain body. These glazes form, with the surface layer of the porcelain, combinations which may behave very differently from the body. The composition of the glaze does not in this case play so predominating a part as in the case of high-tension insulator glazes.

In insulator design, much use is made of the strengthening effect of the glaze on insulator bodies. Previously, the attachment of the porcelain to the metal work was facilitated by the provision of unglazed or partially glazed surfaces in contact with cement. In present-day designs, in place of the conventional form of insulator head, a smooth and unbroken glazed surface—especially in the design of cap-and-pin insulators—has been introduced. Other types which make use of the strengthening effect of the glazes on insulator bodies are the solid-core line and station post insulators, and the so-called motor and long-rod insulators which are used on the Continent to a very great extent as suspension and strain insulators.

FORTHCOMING EVENTS

Friday, January 1

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 2.30 p.m.—Miss Evelyn Cheesman: "Camps in New Guinea" (First Christmas Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ANALYTICAL CHEMIST to the City of York Electricity Department—The City Electrical Engineer, Electricity Offices, Clifford Street, York (endorsed 'Chemist') (December 31).

HEADMASTER of Felsted School—The Clerk to the Governors, Mr. Norman Orfeur, Solicitor, Braintree, Essex (December 31).

CHIEF LAND DRAINAGE OFFICER—The Executive Officer, Bucks War Agricultural Executive Committee, County Offices, Aylesbury, Bucks (Jan. 1).

LECTURER IN CHEMISTRY at the Brighton Technical College—The Education Officer, 54 Old Steine, Brighton, 1 (Jan. 8).

HEAD of the Engineering Department—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (January 9).

LECTURER IN MECHANICAL ENGINEERING in the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (Jan. 17).

DIRECTOR of the National Froebel Foundation—The Secretary, National Froebel Foundation, 2 Manchester Square, London, W.1 (February 27).

CHAIR OF MINING—The Secretary, the University, Edmund Street Birmingham, 3 (March 1)

TWO CHEMISTS IN THE MINISTRY OF SUPPLY whose duties would be of an advisory, non-experimental nature—The Ministry of Labour and National Service, Central (Technical and Scientific) Register (Reference F.651), Sardinia Street, Kingsway, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Abstracts of Dissertations approved for the Ph.D., M.Sc., and M.Litt. Degrees in the University of Cambridge during the Academical Year 1940–1941. Pp. 120. (Cambridge: At the University Press.) [412

University of Cambridge: Solar Physics Observatory. Report for the Year 1941 October 1 to 1942 September 30. Pp. 2. (Cambridge: Solar Physics Observatory.) [1112

Geology and Geologists in the War and the Peace. A Talk given before the Parliamentary and Scientific Committee by Prof. H. H. Read. Pp. 20. (London: Parliamentary and Scientific Committee.) [1412

The London Naturalist. The Journal of the London Natural History Society for the Year 1941. Pp. 52. (London: London Natural History Society.) 3*s.* 6*d.* [1712

Geological Survey of Great Britain: England and Wales. Wartime Pamphlet No. 8: British Phosphates, Part 4: Occurrences of Phosphate in Pre-Cretaceous Rocks. By Dr. Kenneth P. Oakley. Pp. 27. 1*s.* 6*d.* Wartime Pamphlet No. 13: Limestones of Scotland, Area 7: Northern and North-Western Scotland. By Dr. T. Robertson, J. Knox and Dr. J. G. C. Anderson; with Analyses by Dr. A. Muir and H. G. M. Hardie. Pp. 36. 1*s.* 9*d.* (London: Geological Survey and Museum.) [1712

The London Bird Report for 1941: an Annual Report on Bird-Life within Twenty Miles of St. Paul's Cathedral. Edited by R. S. R. Fitter, assisted by R. W. Hale and E. R. Parrinder. Pp. 20. (London: London Natural History Society.) 1*s.* 6*d.* [1712

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